The FOUNDRY

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Health Machine Operates with Aid of Castings

TRIM and accurate die castings are built into an ingenious exercising machine which is used by many of today's shrewd, clear thinking men and women of affairs. A machine of this nature, which brings the pleasure of rowing into the privacy of the

Die Castings Are Used in Various Parts of this Portable Rowing Machine

home must be strong and rigid. The need for portability recommends the use of light aluminum alloys in the castings for the frame, the seat, the foot pedals and the levers which hold the foot pedals in place. The frame consists of two castings, hinged at the center to permit the machine to be folded up and packed in a small case. The seat operates on hard rubber wheels in a groove on the frame. The foot pedals, cast integral, are attached to the frame by four levers so that a rocker arm action may be obtained. Six steel springs fastened to the rear of the frame are connected to the seat or handles by cord in 12 different tension combinations. The sharp lines and well defined ornamentation of the casting add greatly to the attractiveness of the machine, which is manufactured by the Health Developing Apparatus Co., New York.

Find Where Castings Can Be Sold.

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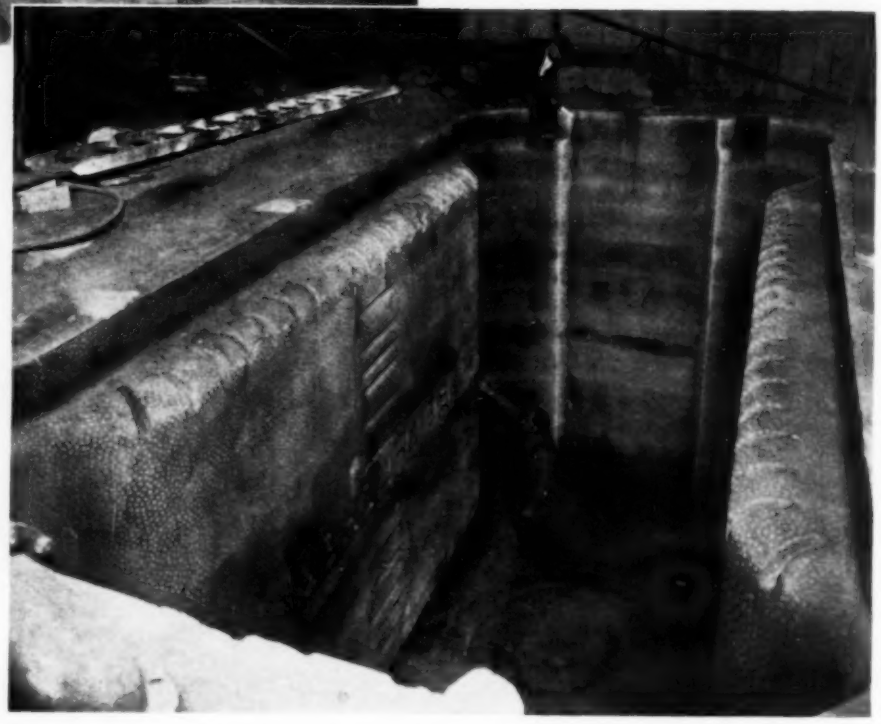
Makes

Fig. 1 (Left) — Metal Was Poured Simultaneously from Four Ladles. Fig. 2 (Below) — Hot Air Was Driven Through a Pipe At Each End To Dry the Mold



FAMOUS for many years as a producer of heavy iron and steel castings, the Bethlehem Steel Co., Inc., at the Lehigh plant, Bethlehem, Pa., shattered all records early in the year by melting and then pouring almost 300 tons of steel into a single casting, the platen for a huge hydraulic forging press. The casting was poured on Sunday, the only day in the week when the battery of six open-hearth furnaces and most of the cranes could be pressed into service and synchronized to function in unison on one job. The casting shown in different positions in several of the accompanying illustrations was estimated from the blue prints to weigh 460,000 pounds, or 230 tons. Gross weight of metal in the casting, including sink heads, runners and gates was 580,000 pounds, 290 tons.

The casting, 10 feet 2 inches wide, 12 feet 10 inches high and 23 feet 4 inches in length, was designed and cast to take the place of a cast iron platen on an armor plate forging press capable of exerting a pressure of 14,000 tons. This press was built in 1891 and was the largest and most powerful of its kind in the world until within the past year when one of approximately the same capacity was erected at Krupp's in Essen, Germany.

Other interesting features of this press include the following: Total height to bottom of crane girder, 54 feet, of which 17 feet is below the floor level; width between columns 13 feet 10 inches; height from pit to crosshead, maximum, 17 feet; stroke 9 feet; two plungers 50½ inches diameter working on a pressure of 7000 pounds per square inch exert a pressure of 14,000 tons.

The upper platen is supported on four annealed steel columns 26 inches diameter. Each nut holding down the top platen is 3 feet 6 inches high. The original cast iron top platen was made up of two sections and the cylinders were cast steel. Altogether a remarkably massive piece of machinery entailing a high degree of skill and knowledge on the part of all those responsible for its fabrication and erection.

Not the least remarkable feature in the entire performance recently where the press was dismantled and a steel casting substituted for the broken iron casting was the time taken to complete the work, particularly in the foundry where half the elapsed time was consumed in

LARGEST STEEL CASTING

Platen for Huge Hydraulic Forging Press, Which Was Poured by Bethlehem, Required Nearly 300 Tons of Steel

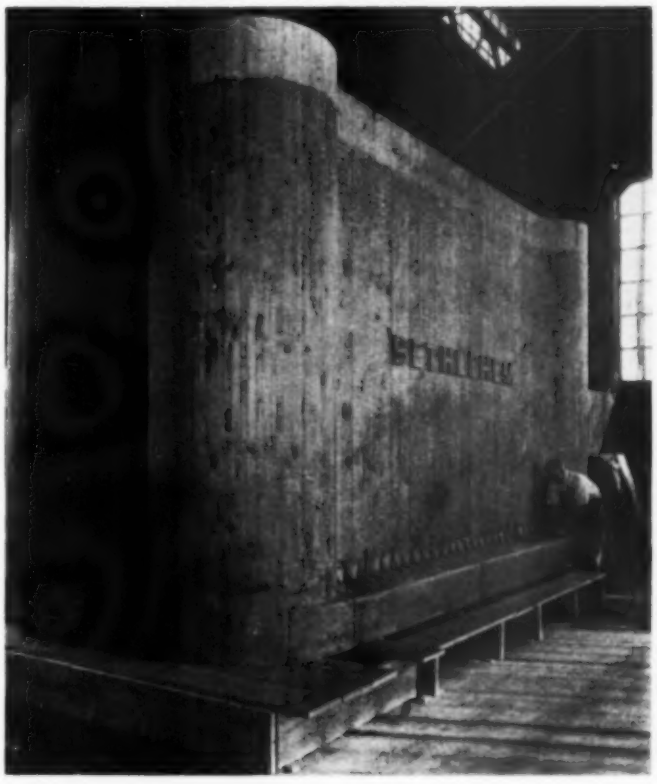
the drying of the huge mold and its heavy cores.

The old platen broke at 11:30 p. m., Nov. 30, while the press was working near the top of the stroke. The flange on the north cylinder gave way and the cylinder was pushed up through the platen, thus shattering the platen around the northeast column. The broken area of the platen extended over the south cylinder and around the northwest column.

The engineering department decided to replace the two-part cast iron platen with a one-piece steel casting of a size and weight never before attempted. A preliminary estimate indicated that the machined and finished casting would weigh 460,000 pounds.

Three days later the drawings were in the pattern shop and the actual work of replacement might be said to be fairly under way. One week after the accident, that is on Dec. 8, the pattern was delivered to the steel foundry. On the following Saturday, Dec. 13, the pattern was drawn out of the mold. Subsequent operation of finishing, drying, coring, closing, weighting and making up the runners occupied another two-week period. The casting was poured on Jan. 4 and the first stripping operation commenced 10 days later. On Jan. 23, the casting was lifted out of the pit.

After the casting was cleaned it was taken to the forge department where it was annealed



for 9½ days and then placed on a special concrete pad where the necessary machining operations were performed by machines set up in the vicinity for this special purpose. All six holes were bored and faced simultaneously.

A special crane and crane runway were erect-

Fig. 3 (Left)—The Platen As It Appeared On the Way Into the Annealing Furnace. Fig. 4 (Above)—Outside Its Immense Size the Pattern Presented No Unusual Features. It Was Constructed in Sections and Assembled Temporarily in the Pattern Shop

ed above the press to lift the platen into place. The crane rail was 62 feet above the pit and the crane was equipped with two 100-ton hoists with hoisting speed synchronized to keep the casting level.

Except for the extreme size, the construction of the pattern presented no unusual features. A frame was set up, as shown in Fig. 5, and then lagged on the outside with 1-inch lumber. The flanges were built separately and fitted with brackets to save the molder the trouble of cutting them in the sand; also to guide him in setting the rods employed to reinforce the sand over the flange. A large vertical core print was attached to each end to locate the cores which formed the space between the columns. The outside of the pattern, as it neared completion, is shown in Fig. 4. It was built in several sections properly fitted and marked for identification. The letters on the side attached temporarily for the purpose of making a photograph, later were removed and placed in a corebox. Their place on the pattern was taken by a core print. The letter cores were placed in the impression left by this print during the process of finishing the face of the mold. In this manner a sharper and cleaner impression of the letters was secured than if they had been formed directly in the sand on the face of the mold.

Experience gained over a period of many years in the preparation of patterns for large steel castings indicated that the usually accepted standard shrinkage allowance of ¼-inch to the foot did not apply in this instance. A shrinkage allowance of ⅛-inch to the foot was allowed and the casting came out almost exactly as anticipated. In height and width the casting conformed precisely to dimensions. In length the casting exceeded expectation by ½-inch, but extra stock had been allowed on all machining surfaces to take care of any possible discrepancy of this kind. The pattern and coreboxes required 13,060 feet of lumber and 250 man-hours in the construction. The elapsed time was 5 days from the receipt of the drawing to the delivery of the pattern and coreboxes to the foundry for molding operations.

Fig. 5—View of Dismantled Pattern Showing Construction Detail. Parts Were Numbered for Reassembling in the Foundry

The mold was made in a pit 15 x 30 feet and 16 feet in depth. These dimensions allowed a margin of 2 feet 4 inches at the sides, 3 feet 4 inches at the ends and 3 feet 2 inches in height. This space was reduced in size by a steel flask which surrounded the sand in the mold and which was braced firmly against the walls of the pit. Adjoining pits were reinforced and then filled with sand which was rammed firmly. Every precaution was taken to insure the rigidity of the mold subjected to such a terrific static pressure under sink heads that extended 5 feet above the top of the casting.

Precautions Are Taken

Large cast iron slabs 6 inches thick were laid on the concrete bottom of the pit and these in turn were covered with a 4-inch thickness of sand. With this arrangement it was felt reasonably certain that the weight of metal in the mold would not distort the bottom face. The sand bed was rammed firmly and then struck off to a level surface on which the pattern was placed.

Gate openings 4 x 4 inches were built in bricks at two points on the lower flange on one side and at two points at the bottom of each end. The end gates opened into large square lugs designed and attached to the casting, specifically for the purpose of facilitating handling in the several stages of the journey between the casting pit and its position as the upper member of the forging press. Supplementary gates were arranged at points half way between the top and the bottom, and at the top flange.

The sprues in 6-inch tiles were built up in sections as the ramming of the sand progressed. The pro-

Fig. 6—Top View of Finished Mold with All Cores in Place Except the Lightening Cores at the Ends and Two Column Cores

jecting body of sand between the upper and lower flange on each side was supported by chuck bars bolted to the sides of the flask and extending to within 4 inches of the face of the pattern. In addition to the usual rods and gaggers in the walls of the mold, the entire face of the mold was reinforced with nails after the pattern was withdrawn. The faces of the cores were treated in the same manner. A total of 2 tons of nails was used for this purpose.

A rather unusual method was employed for drying the mold. Instead of gas jets or coke baskets located directly in the mold, the fire was built in a core oven and the hot air was piped from the oven in two 6-inch pipes and discharged into the bottom of the mold through the sprue and gates at the ends. A fan at the oven provided the necessary circulation. By this method the sand was dried slowly and uniformly to an approximate depth of 12 inches.

Cope Rammed Separately

Instead of waiting until the drag was ready, the cope was rammed on a large plate laid down for the purpose. Thus both parts of the mold were ready simultaneously. The cope was placed temporarily on the drag for a lid and both parts were dried at the same time.

Preparation of the cores also proceeded simultaneously with the preparation of the mold. Each of the two main or cylinder cores was made in three sections and weighed approximately 60 tons. The four column cores were made and dried horizontally in halves and afterward jointed and assembled. The inside of each core was filled with coke and old sand and the shoulders on the outside were bracketed liberally to resist contraction strains in the casting which occur in those areas.

The cope was wedged down under long steel beams. Approximately 500 tons of miscellaneous castings were pressed into service temporarily as weights. The actual pressure against the face of the cope, assuming that the surface was not broken by core openings was 10 x 24 x 7 x 4 in which 10 is the width in feet, 24 is the length, 7 is the height from the face of the casting to the top of the sink head, and 4 is the number of cubic feet of steel in a ton. This calculation shows that a total of 420 tons of weight was required to hold the cope in place. The difference of 80 tons, plus the deduction to be made for core openings, represent the safety factor dictated by prudence.

After the mold was closed and weighted, long runner basins had to be erected at the ends and at one side for the simultaneous pouring of metal from four ladles, each ladle suspended from a traveling crane and every crane running on the same runway. The arrangement of the four runner basins with the metal flowing toward the mold, is shown in Fig. 1. The runner basins were formed in sand in long steel flasks and were dried the same as any other part of the mold. Temporary piers made up of empty flasks and short sections of rails supported the runner basin in a slanting position that insured rapid movement of the metal from the outer to the inner end where it entered the vertical sprue leading to the gates at the bottom of the mold.

Metal was melted in six open-hearth furnaces of varying capacity and the nicest degree of skill, judgment and manipulation was required to bring the steel in all the furnaces to the tapping point simultaneously. The steel from four large furnaces was tapped into four large ladles which were carried to the mold and emptied. The contents of two smaller furnaces approximately 60 tons were tapped into a single ladle and held there until one of the end ladles was emptied. The crane was disengaged from the empty ladle and attached to what may be termed the fifth ladle in the group. The metal

Fig. 8—A Crane at Each End Equipped with Equalizer Beams Lifted the Casting Out of the Pit in Which It Had Been Cast

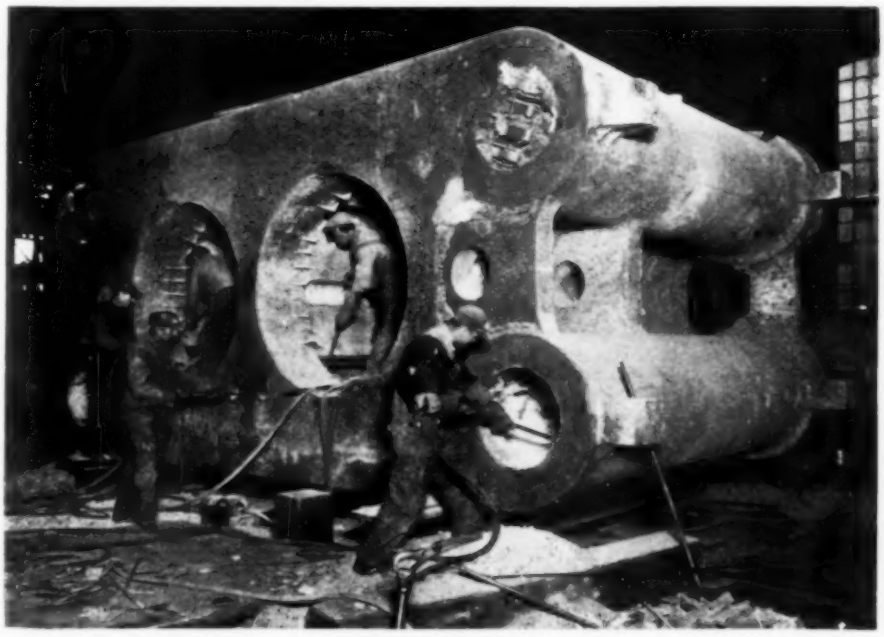


Fig. 7—Despite the Immense Size and Weight the Sand Peeled Readily From the Outside and Inside of the Casting

from this ladle was employed to fill the sink heads, one over each column and two over the center.

Each column sink head was 50 inches diameter, 5 feet high above the cope with a continuation of the 24-inch diameter core through the center. The sink heads over the center section of the casting rectangular in cross section 36 x 48 inches and the same height as the others, 5 feet. The steel from all six furnaces conformed to the following analysis: Carbon 0.20-0.25 per cent, manganese 0.45-0.50 per cent, sulphur 0.04 per cent, phosphorus 0.025 per cent, silicon 0.22-0.25 per cent.

The pouring of metal into the mold proper extending over a period of 10 minutes. Total pouring time, that is the elapsed time between the lifting of the first ladle stopper and the entrance of the last drop of metal in the sink heads occupied 38 minutes. A covering of sand was thrown over the top of the sink heads and no further action was taken for 10 days. The weights then were removed followed by the cope. The sink head metal was cut off with an acetylene torch.

On account of the great weight of the combined casting and cores, a great deal of the preliminary cleaning was done in the pit before the casting was removed. The flask and sand were removed from around the outside, the large cores were removed from the ends and a considerable volume of the material was removed from the cylinder and column cavities.

The casting was lifted from the pit by two 125-ton cranes 19 days after the metal was poured into the mold. Method of attaching the cranes by equallizer bars at each end is shown in Fig. 8. The casting was loaded on a buggy in a vertical position and taken to the forge shop where it was turned on its side and loaded on a car running on rollers which conveyed it into the annealing furnace where it remained for 9½ days.

After this heating or normalizing treatment, the casting was set up on a special concrete foundation erected for the purpose, flush with the floor of the forge shop. Instead of the usual practice of bringing the casting to the machine, the machines to the number of six in this instance, were brought to the casting. The machines were operated simultaneously to bore and face the two cylinder and four column openings.

A supplement to circular No. 25 recently issued by the bureau of standards gives information on standard samples issued or in preparation. Data are given on the sample numbers, their names, constituents determined or intended use, weights of samples and prices. Information also is given on the averaged analyses.

Cleveland Committee Is Organized

In accordance with the plans of furthering the activities of the American Society for Testing Materials, and bringing the activities closer to the general membership, a district committee has been formed in Cleveland with divisions in Akron and Youngstown. The personnel of the general committee is as follows:

H. A. Schwartz, National Malleable & Steel Castings Co.; R. J. Anderson; H. M. Boylston, Case School of Applied Science; F. C. Elder, American Steel & Wire Co.; J. V. Emmons, Cleveland Twist Drill Co.; Zay Jeffries, Aluminum Co. of America; H. J. Love, National Slag association; C. B. Murray, Crowell & Murray Inc.; A. J. Tuscany, Gray Iron institute; E. E. Ware, Sherwin-Williams Co.; Dan M. Avey, THE FOUNDRY, and W. H. Eisenman, American Society for Steel Treating.

The Akron division is composed of A. W. Carpenter, B. F. Goodrich Co.; J. J. Allen, Firestone Tire & Rubber Co., and E. G. Kimmich, Goodyear Tire & Rubber Co. The Youngstown division members are G. A. Reinhardt, Youngstown Sheet & Tube Co.; L. B. Grindlay, Republic Steel Corp., and Fred Hubbard, Standard Slag Co. H. A. Schwartz has been appointed chairman of the general committee with W. H. Eisenman, vice chairman, and Dan M. Avey, secretary. A. W. Carpenter is chairman of the Akron division, and G. A. Reinhardt, chairman of the Youngstown division.

Book Review

Standards of the Hydraulic Society, sixth edition, 1931, 96 pages, paper, 8½ x 11 inches, published by the Hydraulic society, C. H. Rohrbach, secretary, 90 West street, New York, available from THE FOUNDRY for $1.00 plus 15.00c postage and in London from the Penton Publishing Co., Ltd., Caxton House, Westminster for 5s postage extra.

Commercial and technical material in the hydraulic field contained in the publication is submitted as the opinion and recommendation of the Hydraulic society as to what is considered good practice in the pump industry. The society is a trade association comprising the principal manufacturers of displacement and centrifugal pumps in the United States. In co-operation with the department of commerce, the United States chamber of commerce, the American Society of Mechanical Engineers, and other association with which the pump industry has problems in common, the society aims to aid users of pumps, as well as its own members.

The publication outlines principles of business conduct approved by the society and carries a complete set of standard technical definitions and values applicable to the field. The material coincides with the American Society of Mechanical Engineers power test codes, but is extended to cover more completely the hydraulic and pumping phases. Complete classification of pumps is given including illustration of various types and parts. Operating instructions are given and contract forms recommended. Data, tables, curves, and formulae are given for hydraulic problems commonly met in industrial applications.

Institute of Metals To Meet in Zurich

A list of the papers to be presented at the autumn meeting of the British Institute of Metals to be held Sept. 14 and 15 in Zurich includes several of interest to the foundrymen. Among them are "The Oxidation of Some Copper Alloys," by Dunn; "Unsoundness in Aluminum Sand Castings. Part II—The Effects of Using Metal Previously Subjected to Corrosive Conditions," by Hanson and Slater; "The Macro-etching of Aluminum-Silicon Alloys," by Hume-Rothery; "Nickel-Copper Alloys of High Elastic Limit," by Jones, Pfeil and Griffiths; "The Protection of Magnesium Alloys Against Corrosion," by Sutton and Le Brocq; and "Note of the Failure of a High-Strength Brass," by Newson and Wragg.

Reorganize Committee

The Chicago district committee of the American Society for Testing Materials which was organized two years ago has been reorganized, and a division of the committee formed for Milwaukee. The general committee is composed of H. G. Farmer, Universal Atlas Cement Co.; H. H. Morgan, Robert W. Hunt Co.; Frank Randall; H. D. Browne, Chicago & North Western Railway Co.; F. M. Carroll, Holabird & Root; T. L. Condron; J. DeN. Macomb, Inland Steel Co.; F. R. McMillan, Portland Cement association, and Grant Monk, Illinois Steel Co. The Milwaukee division is comprised of Ray Newhouse, Allis-Chalmers Mfg. Co., and Charles Wheatley, A. O. Smith Corp. H. G. Farmer is chairman of the reorganized committee, H. H. Morgan is vice chairman, and Frank Randall is secretary.

Will Hold Patent Exhibit

The second International Patent Exhibition will be held at the Merchandise Mart, Chicago, Sept. 14 to 27. The exhibition includes a diversified display of new inventions and patents and a showing of some of the new products of many leading manufacturers. Maj. Gen. George O. Squier, inventor of the liberty motor and numerous other inventions, is honorary chairman of the exposition. B. Hamilton Edison is managing director.

Pattern Lumber Includes a Variety of Woods

Many Woods Are Used in the Manufacture of Patterns and Each is Subject to Different Methods of Grading—Defects Also Are Classified Differently

By Norman F Hindle

NO SINGLE species of tree has supplied more lumber to the United States than the white pine, known technically as *pinus strobus*. That species also is of great value and interest to the foundry industry. Wood is used in the foundry industry for many purposes, but that which demands the most care in selection and greatest freedom from defects is used in the manufacture of patterns.

Properties of Ideal Lumber

According to Joseph A. Shelly, in his book *Patternmaking*, the ideal lumber for patterns should be fairly soft, straight grained, should not splinter, should be porous enough to glue well, and when properly seasoned should not change its form with variation of temperature and humidity. The majority of authorities seem to agree that white pine most closely approaches the ideal wood. Other woods recommended for patternmaking include, yellow pine, redwood, sugar pine, black cherry, sugar maple, yellow and red birch, beech, whitewood, Washington fir, baywood, mahogany, and cedar.

Probably patternmakers are of the opinion that certain of the woods mentioned are totally unfit for patterns. However, Table I shows a list of woods used in the United States for the production of patterns and flasks as compiled by the United States forest service in 1914 in cooperation with the various states. It also shows the percentage of patterns and flasks made from each wood. Since that time conditions have changed and figures given in the table may not hold exactly but they give an idea of the relative value in the foundry of the different species of wood mentioned. Local conditions also influence the use of different types of wood. For example, redwood is used considerably on the Pacific coast for patterns and yellow pine is used in the Southern states for large cylinder work. The particular woods used grow in those sections of the country and consequently find favor there.

More white pine is used in the construction of patterns than any other type of lumber, as may be seen in Table I. That wood comes from a family of trees which is divided into two main classes, the white and yellow. The white pine family includes the common white, western white (pinus monticola), found in western Montana and Idaho, and the sugar pine (pinus lambertiana), which occurs in the Sierra Nevada region of California and southern Oregon. There are far more divisions of the yellow pine family which includes the longleaf pine (pinus palustris), shortleaf pine (pinus echinata), loblolly pine (pinus taeda), and cuban pine, (pinus heterophylla), native to the Southern states; pitch pine (pinus rigida), found in the Northern and Eastern states; Norway or red pine (pinus resenosa), occuring in the New England and Lake states; jack pine (pinus dioarecata), seen in the lake states; lodgepole pine (pinus contorta), natives of the Rocky Mountain region; and the western yellow pine (pinus ponderosa), found in a district stretching from the Black Hills to the Pacific coast.

Table I

Pattern Lumber Used

Wood	Per Cent
White Pine	75
Yellow Pine	8
Redwood	4
Hemlock	2
Spruce	2
Yellow Poplar	1
Sugar Pine	1
Mahogany	1
Cedar	1
Other Woods	5
Total	100

The above figures were compiled by the United States forest service in a survey in 1914 and includes both pattern and flask lumber.

Sugar pine is used for patterns and in many cases is found to be satisfactory. It is a soft wood with a uniform texture and is worked easily. The wood cells are open and the wood is spongy. It is claimed to be relatively free from shrinkage, swelling, warping and twisting and to hold glue, paint and shellac well. As maybe seen in Tables II and III, sugar pine appears to be slightly inferior in physical properties to white pine and a little better than the yellow variety. It is superior to white pine only in shear strength. However, it exceeds yellow pine in shear strength, crushing strength, modulus of rupture and is less in specific gravity, toughness, modulus of elasticity and resistance to impact. Therefore as far as physical properties are concerned, yellow pine is superior to sugar pine only in elasticity, resistance to impact, and hardness, although those are extremely important properties.

Baywood Finds Favor

Baywood, a specie of mahogany, has found favor with patternmakers during the past few years. Many shops use it in preference to white pine because it is exceptionally durable, light and is worked easily. It has straight grain and close texture, checks, shrinks and warps only slightly, and keeps its shape well. English patternmakers also use African mahogany. It is cheaper in price but does not compare favorably with baywood since it is prone to contain shakes and to be extremely absorbent. It may be obtained in large sizes and the best quality is said to come from the Lagos district. Gaboon mahogany is not used for pattern work. However, those types of mahogany are not used in the United States.

Redwood is a large tree which grows in the Western states

and is used considerably on the Pacific coast for patterns. It has a large open texture and splinters easily. It is not an exceptionally durable wood, but if the patterns made of it are shellaced heavily, they will stand up for short runs.

Mahogany Is Used

Mahogany is probably the best of the hard woods for patterns. However, its high price and difficulty in working prohibit its use in large patterns. It is used extensively in small patterns and especially those where fragility is a factor. It has a hard, dense surface, is harder to work than pine and does not take varnish and glue as readily. It is recommended for patterns which must stand abuse and constant use. F. W. Barrows, in *Practical Patternmaking*, recommends Cuban and Mexican species while Clarence F. Nelson, THE FOUNDRY, Aug. 1, 1926, says, "Mexican and Spanish mahogany are used but little as the former is not straight grained and warps considerably in the sand, while the latter is of a wavy and knotty nature. These woods may be used in patterns of small solid types." Mahogany is not as susceptible to atmospheric changes as pine, according to Barrows, and therefore should not be as subject to warping, swelling and checking.

Wild black cherry (prunus serotina) is used quite extensively in pattern work. It is lighter and softer than beech and birch and is dense, strong, durable and generally has straight grain although some pieces are hard to work. It warps only slightly but is not so immune to temperature and humidity changes as mahogany. It also is cheaper than mahogany. Cherry is especially good for intricate designs that are too large to be made of metal and for matchplate work where metal would give excessive weight. Physical properties of cherry are shown in Tables II and III.

Hard or sugar maple (acer saccharum) is used in many patterns and finds extensive application in lathe work. It is a strong, hard wood with good wearing qualities, takes a good, smooth finish but must be kept well varnished. Barrows, *Practical Patternmaking*, recommends its use in patterns while Nelson, THE FOUNDRY, Aug. 1, 1926, does not favor it. The latter also lists oak, gum, spruce, chestnut, cypress, whitewood, cottonwood, alder and hemlock as being unsuited for patterns. He recommends black walnut, boxwood, rosewood, vermillion, etc., the odds and ends of furniture factories, as good pattern lumber, but says that the cost is too high for general use and purchase.

Beech also is a wood that may be utilized for patterns. Its physical properties approximate those of cherry, maple and birch. It is good for lathe work, takes a good finish but must be kept well varnished. It is favored in England for extremely small patterns. Both red and yellow birch are used to some extent. The tree grows in the Lake states, New York and New England. Birch is a heavy wood for average hardness, stiffness and strength among the hard woods but is above the average in toughness and is correspondingly hard to work.

Lists Lumber for Patterns

Authorities appear to agree that white pine, yellow pine, sugar pine, redwood, mahogany, baywood, cherry, maple, birch and beech are the best woods for patterns, provided, of course, they are used in the type of work they are most suited. English patternmakers appear to favor yellow pine, sometimes called Weymouth pine, white pine, canary, basswood, beech, teak, baywood and mahogany.

Patternmakers generally form an opinion as to which wood is the best for their particular needs. However, each pattern that comes into the shop should be studied so that the best wood with regard to economy and service may be used. Often, more than one type wood is necessary to give the pattern the desired characteristics and to make it durable. Design influences the species of lumber that will make a good wearing, substantial pattern. Cost also is a vital factor in production. A study of the correct lumber to use in the pattern, including the various parts that are subjected to varying degrees of wear, will reduce pattern costs by keeping down repairs. Every patternmaker should make a study of the lumber that he uses so that he may judge the condition of the lumber as it comes to him from his source of supply.

Subject To Defects

Often foundrymen conducting a pattern shop rely on the lumber yard to send them the type of lumber required, when the supplier may not be a competent judge of the requirements of pattern lumber. Thus, the patternmaker often receives lumber that can be used for patterns, but it is not the best and may result in excessive wastage. Such a condition would be eliminated if the patternmaker gave sufficient thought and study to the lumber problem.

Lumber is subject to many defects and that used for patterns should contain as few of these as possible with due regard to ease of production and cost. Defects in white pine

Table II

Wood Tested in Air Dry Condition

(Small Clear Pieces Used)

Hardwoods	Moisture Per Cent	Specific Gravity	Weight Per Cubic Foot Pounds	Static Bending Fiber Stress at Elastic Limit lbs. per sq. in.	Modulus of Elasticity Thousands of lbs./sq. in.	Modulus of Rupture lbs./sq. in.	Work in Bending Elastic limit in. lb. per sq. in.	Work in Bending Maximum load, in. lb. per sq. in.
Black Cherry	9.2	0.51	35	11000	1540	13800	4.48	11.0
Sugar Maple	10.5	0.62	43	10400	1820	15800	3.52	13.6
Yellow Birch	9.6	0.63	44	12300	2200	18900	3.93	20.2
Beech	11.2	0.63	44	9000	1680	15000	2.91	13.7
Mahogany*	.....	0.34-0.90	....	.....	1510	14000	.....	.....
Red Birch	9.0	0.66	45	13300	2140	19600	4.56	17.0
Soft Woods								
White Pine	9.9	0.39	27	7000	1420	9600	2.04	6.4
Sugar Pine	11.4	0.37	26	6400	1210	8600	1.79	5.0
Yellow Pine (Norway)	12.5	0.48	34	9200	1790	12300	2.68	9.9
Cedar	9.0	0.45	31	8900	2040	14500	2.25	7.2

Bulletin No. 556, U. S. department of agriculture, 1917, by J. A. Newlin and Thomas R. C. Wilson
*Principal Species of Wood, by C. H. Snow

will be discussed and defined first. The Northern Pine Manufacturers' association, Western Pine Manufacturers' association and the White Pine Association of the Tonawandas co-operated in compiling a standard set of grading rules for that wood. The rules were published by the White Pine bureau, St. Paul, Minn., representing the Northern Pine Manufacturers' Association of Minnesota, Wisconsin and Michigan and the Associated White Pine Manufacturers of Idaho. The following are listed as recognized defects in white pine lumber: Knots, knot holes, sap, sap stain, shakes, checks, splits, pitch pockets, pitch streaks, wane, worm holes, chip grain, torn grain and loosened grain.

Knots Are Defined

Knots are classified as pin, pencil, small, large or coarse as to size; round, branch or spike, as to form; and sound, loose, incased, pitch, and rotten as to quality. Pin or pencil type is described as sound and not in excess of ½-inch diameter; a small knot, between ½ and 1½ inches in diameter; a large or coarse knot, any size over 1½-inch in diameter. A round knot is oval or circular in form while the spike or branch type is one sawed lengthwise of the knot. A sound knot is one solid across its face, is as hard as the wood that surrounds it, may be either black or red, and is fixed by growth or position so that it will retain its place in the piece. Loose knots are those not set firmly but which still remain in place in the board. An incased knot is one surrounded entirely by bark or pitch. A pitch knot is sound with a pitch hole not more than 1¼-inch diameter. Rotten types are those decayed beyond the surrounding wood.

Sap growth just inside the bark on the outside of the log is called a sap defect. Sap stain is the name applied to blue or discolored sap. Slight openings in the grain following the growth rings in circular form in the log are known as shakes. Checks are openings in and usually, though not necessarily, following the grain of the wood. Splits are checks or openings in the wood at the end of the piece, usually following the grain of the wood. Pitch pockets are cups or pockets in the openings between the grain of the wood, in which liquid or dried pitch is deposited. They are classed as small, not over ⅛-inch wide; medium, not over ⅜-inch wide or 3 inches long; and large, any dimension over those given for the medium classification. A pitch pocket showing open on both sides of a piece, where the opening is ⅛-inch wide or more is considered the same as a knot hole. Pitch streaks are the result of pitch penetrating into the grain of the wood.

Piece Is Not Square

Wane is the name of the defect resulting from the piece not being square-edged and is caused by the bark on the edge being removed. The term worm holes is self explanatory. Chip grain consists of the surface being slightly chipped below the cut line and usually is not classed as torn grain nor as a defect. Torn grain denotes small particles of the wood being torn out in dressing and occurs around knots and curley places. That defect is divided into four classes, slight, medium, heavy and deep. Slight torn grain is not more than 1/32-inch in depth; medium torn grain, 1/16 inch deep; heavy torn grain, ⅛ inch deep and deep torn grain, over these depths.

In 1929, the Western Pine Manufacturers' association and the California White & Sugar Pine Manufacturers' association drafted a new set of grading rules which became effective July 1, 1929, and in which the list of defects was made more specific. In addition to the defects named previously, that list includes such terms as bark pocket, decay, heart pith, heart shake, skip, machine burn, warp, crook, bow and cup. The term stain has been divided into several classes according to the depth of color and wormholes have been classified as pin and small.

Defects Govern Grade

The previously mentioned defects govern the grade into which a piece of lumber is placed. The number and extent of defects determines the grade. In strict terms of the lumber manufacturer and dealer, there is no such term as *pattern lumber.* White pine is classed as B select and better; C and D select; No. 1, 2 and 3 shop; and Nos. 1, 2 and 3 common. Grade B select and better includes first, second and third clear, the highest grades of lumber, A select, which is a medium type, and B select, the lowest type in the best class. Those grades contain few of the standard defects and are the best class of white pine lumber obtainable. Shop and common grades contain larger number of defects but are good lumber. Clear and select lumber may be purchased separately if those grades are desired.

Sugar pine is graded by the rules previously mentioned and is classified as No. 1 and 2 clear; C and D select; No. 1, 2, 3, and 4 common; No. 3 clear, No. 1, 2, and 3 shop.

This is the first of a series of two articles dealing with grading rules, defects and methods of drying pattern lumber.

THE EDITORS.

Table III

Additional Properties of Air Dried Wood

(Small Clear Pieces Used)

Hardwoods	Impact Fiber Stress at Elastic Limit lbs./sq. in.	Bending Work to Elastic Limit in lbs. per cu. in.	Height of drop Causing Complete Failure with 50 lb. Hammer	Compression Fiber Stress at Elastic Limit in lbs./sq. in.	Parallel to Grain Max. Crushing Strength lbs./sq. in.	Compression Perpendicular to grain lbs./sq. in.	Shearing Strength Parallel to grain lbs. per sq. in.	Torsion Perpendicular to grain lbs. per sq. in.	Hardness pressure in lbs. to indent Specimen to depth of ½ diameter of 0.444-inch steel ball End	Hardness pressure in lbs. to indent Specimen to depth of ½ diameter of 0.444-inch steel ball Side
Black Cherry	14,800	5.9	28	7330	8370	1020	1930	560	1690	1030
Sugar Maple	19,100	9.3	33	6060	8570	1620	2450	770	2000	1430
Yellow Birch	21,200	9.9	58	7720	9760	1410	1880	890	1590	1320
Beech	19,700	9.2	35	4870	7400	1340	1970	890	1400	1190
Mahogany										
Red Birch	26,700	13.2	48	7220	10680	1750	2680	610	2090	1490
Soft Woods										
White Pine	9300	3.3	18	5070	6360	760	1070	340	610	470
Sugar Pine	10,100	4.3	17	4740	5190	640	1080	350	650	460
Yellow Pine (Norway)	15,100	6.3	25	5660	7080	830	1260	470	700	600
Cedar	17,600	7.2	39	7700	7750	1020	1500	630	950	700

Composition, Temperature, Time, And Control Govern Short Anneal

By Edwin Bremer

WHILE the several published accounts mentioned previously show that short or comparatively short annealing cycles have been employed at various times, it appears that it was not until 1918 that a really definite attempt was made to ascertain just how rapidly white cast iron could be converted to malleable cast iron. The work was conducted by the late H. E. Diller and his results were embodied in a paper presented at the 1918 convention of the American Foundrymen's association. The following extracts are interesting:

"The time usually taken for an anneal seems a great deal too long, but I do not believe that it can be shortened appreciably without radical change in present methods. In order to find out just how quickly a piece of iron could be malleableized and to learn the effects of different packings and gases, I made some experiments while working in the research laboratory of the General Electric Co. at Schenectady, and the following are some details of these experiments.

"To start with a number of test bars were obtained which all were cast from the same iron. Their composition was: Silicon, 0.71 per cent; sulphur, 0.059 per cent; phosphorus, 0.168 per cent; manganese, 0.27 per cent; combined carbon, 2.68 per cent, and total carbon, 2.68 per cent.

"The first experiments were made in an Arsem vacuum furnace where the sample was away from air and other gases with the exception of the gases which might be given off by the sample, the carbon resistors, or by the packing, and which would be rarified. No anneals were made which brought the combined carbon below 0.30 per cent, and the following anneal was found to give as good results as a somewhat longer anneal: Time to temperature, 1½ hours; time at 1000 degrees Cent. (1832 degrees Fahr.), 6 hours; time cooling to 600 degrees Cent. (1112 degrees Fahr.), 3½ hours, and total time for anneal, 11 hours.

"After going through this anneal a bar packed in magnetite had 0.41 per cent combined carbon and a bar packed in alundum had 0.38 per cent combined carbon. The latter would indicate that an anneal could be made in 11 hours without the presence of any oxidizing agent; in fact the small amount of gas which would be in the furnace would be a reducing gas, due to the heated carbon resistors.

"A rectangular bar 0.53 x 1.02 inches, subjected to the foregoing anneal and given a tranverse test 12

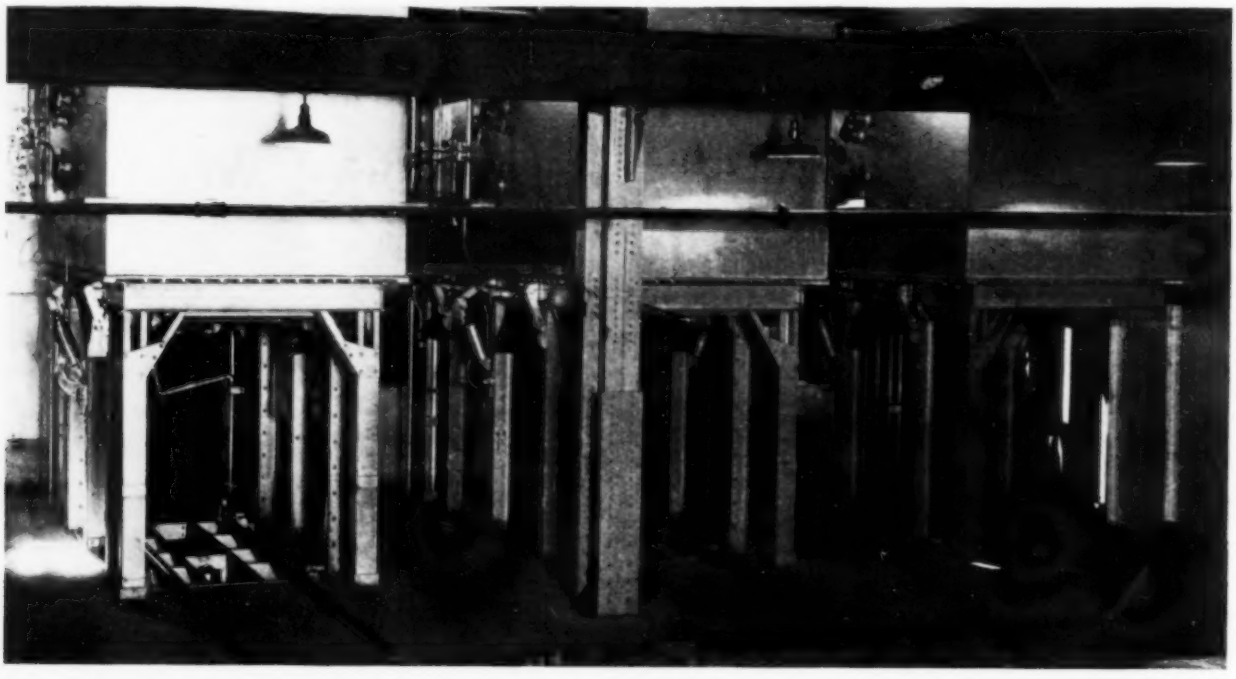


Fig. 4—A Battery of Three Electric Furnaces Is Used in One Installation for Annealing Malleable Castings in a Considerably Shorter Period than Ordinary Practice

inches between supports, sustained a load of 1335 pounds and gave a deflection of 1.02 inches before breaking, while a bar 0.765-inch in diameter gave a tensile strength of 49,360 pounds per square inch. The amount of elongation was not determined as the bar broke at the bench mark.

"The next experiments were made in a silica tube 6 inches in diameter heated from the outside by electrical resistance. Experiments were made to find the minimum time for holding at temperature and for cooling to give satisfactory results. Table II is given showing the best results obtained, using different atmospheres and different mediums for packing. In anneals Nos. 84, 85 and 87, carbon dioxide gas was passed through the tube during anneal, and in anneal No. 73 hydrogen gas was passed through the tube during anneal. In anneals Nos. 69, 86 and 89 no gas was passed through the furnace and the heated bars were in contact with the air which did not have free circulation due to plugs of loose asbestos in the ends of the tube.

"In anneal No. 73 the sample was packed in a 1-inch pipe with alundum and the ends stopped with asbestos. This then was packed in a 3-inch pipe with coke dust and a stream of hydrogen passed through the furnace during the anneal. While there was considerable temper carbon, and only 0.12 per cent combined carbon in the center of the annealed test piece, at the edge of the test piece there was no temper carbon and 0.92 per cent combined carbon.

Heat Is Responsible

"From the foregoing tests it appears that if the composition is correct, the only thing essential to annealing or changing the carbon from the combined state to temper carbon is heat. Anneal No. 73 and the vacuum furnace anneals would indicate that an oxidizing atmosphere is not essential while other anneals would indicate that a reducing atmosphere is not essential. Anneals Nos. 73 and 85 would indicate that oxidizing packing is not essential while other anneals would indicate that a neutral packing is not essential."

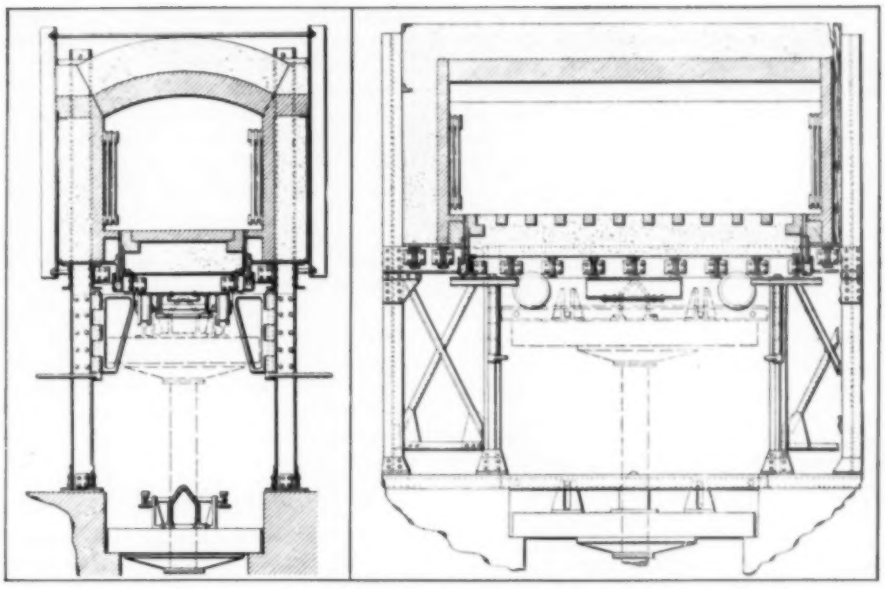


Fig. 5—Sketch Showing Design of Elevated Type Electric Furnace

In 1922 and 1925 Anson Hayes and W. J. Diederichs applied for patents on a "new and improved process for treating white cast iron whereby an iron is produced practically duplicating the properties of commercial malleable iron, and in a much shorter time than now is required in the ordinary malleableizing process," which were granted in 1926. The patent filed in 1922 in brief calls for a heat treatment of the white cast iron in the neighborhood of 1000 degrees Cent. (1832 degrees Fahr.) from about 15 minutes to 5 hours or more; cooling the castings to a temperature between about 850 and 740 degrees Cent. (1562 and 1364 degrees Fahr.) and maintaining the castings at that temperature for a time sufficient to allow a suitable approach to chemical equilibrium of the constituents, and the cooling of the castings at a slow rate of about 5 degrees Cent. (9 degrees Fahr.) per hour.

The application filed in 1925 on a short time anneal calls for the subjecting of the white iron castings to a temperature considerably above the critical temperature of the material for a period of from 15 minutes to 5 hours or more, until the iron carbide practically is all absorbed in the solid solution; cooling the casting by quenching in sand; final heating to a point sufficient to allow structural and chemical changes to progress, and an extremely slow cooling at the rate of about 5 degrees Cent. (9 degrees Fahr) per hour. Both patents also mention the repetition of the first two steps for a number of times before continuing the remaining steps.

Gives Experimental Data

As illustrations of the efficacy of the method the first mentioned patent describes heating a bar of white iron to 1000 degrees Cent. (1832 degrees Fahr.) with the furnace and holding at that temperature for 1 hour. The bar then was cooled to 850 degrees Cent. (1562 degrees Fahr.) with the furnace requiring about 2 hours, and held at that temperature for 6 hours. The bar was allowed to cool slowly at the rate of about 5 degrees Cent. per hour (9 degrees Fahr.), and the resulting material possessed a tensile strength of 49,200 pounds per square inch and an elongation of

Table II

Results of Investigation on Annealing Time

Anneal No.	69	73	84	85	86	87	89
Bar Packed in	Mill Scale	Alundum	Mill Scale	Sand	Powd. Marble	Mill Scale	Magnetite
Time to 900 deg. Cent. hours	8½	8	7½	7½	....	....	....
Time to 850 deg. Cent. hours	....	....	....	....	6½	5½	5
Time at temp. hours	22¼	16	16	17	17	16	18
Highest temp. deg. Cent.	968	900	900	900	879	872	900
Avg. temp. during anneal deg. Cent.	920	900	900	890	870	870	895
Time cooling to 600 deg. Cent. hours	8½	16	8½	28	16	16	16
Total time hours	39¼	40	32	52½	39½	37½	39
Combined Carbon per cent	0.08	0.12	0.07	0.15	0.15	0.16	0.30
Transverse Test							
Deflection inches	1.69	0.73	1.72	1.96	1.38	1.24	1.84
Load pounds	1150	1025	1200	1315	1125	1160	1310

16.5 per cent in 2 inch gage length.

The inventors stated that the overall time for obtaining the results cited was in the neighborhood of 45 hours which they claimed might be reduced by shortening the range of slow cooling, or cooling at a faster rate than 5 degrees per hour. However, the tests were carried out on a laboratory scale, that is to say, the castings annealed were test bars, the furnace employed was small, and the mass that could be treated at any given time consequently was limited.

In actual commercial practice then it is not surprising that the cycle as outlined has been modified to take into account such factors as the variation in section thickness of the castings, variation in composition of the metal to be annealed, the enlarged size of the furnace employed in commercial operation, and the large mass of castings annealed in the furnace. The modifications include longer time to bring the furnace to the required temperature, lower initial holding temperature, and longer time at the holding temperature to allow the castings to come to equilibrium.

Furnace Is Elevated

A special type of electric furnace is employed for the heat treating or annealing operation. It is an overhead type, rectangular in shape similar to that shown in Fig. 1 in the Aug. 15 issue of THE FOUNDRY. The charge to be annealed is loaded without packing material of any sort, on a car topped with refractory brick which is shown just at the left of Fig. 1. The lower portion of the car is constructed so that a continuous groove is formed around the four sides. The groove in some instances is filled with sand, but in annealing malleable iron, the groove is filled with finely divided rouge. The under portion of the furnace contains a tongue around the four sides which fits into the groove containing the rouge on the car, and forms a reasonably effective seal. Further details are shown in Fig. 5 which is taken from the patent for the furnace. The car is elevated into the furnace by hydraulic means, and locked into position by steel dogs.

After the castings are in the furnace, the power is turned on and the annealing cycle begins. While exact details of the cycle employed have not been revealed, it is understood that the first period of 24 hours is devoted to heating up the furnace and castings to, and holding at the temperature of 1750 degrees Fahr. Following that, the temperature is reduced as rapidly as possible to about 1350 degrees Fahr. which is said to take about 1 hour. Then the castings are held at 1350 degrees Fahr. for about 48 hours to allow the precipitation of temper carbon. After the 48-hour period, the castings are cooled to handling temperature.

Reduction of the time in annealing may be attributed to several factors. The first that comes to mind is the type of furnace employed. As shown in Fig. 5, resistor elements are located on four sides of the chamber which tend to maintain a uniformity of heat in all parts of the chamber, and the door which forms the bottom of the furnace is so arranged that the chamber is protected from the ingress of air, or the egress of furnace atmosphere. Also no pots or packing material is used in the process.

Temperature Raised Rapidly

Due to the location of the heating elements on the four walls, it may be expected that the interior of the furnace may be raised to a high temperature more rapidly than in the ordinary batch type annealing oven which is dependent upon convection of the gases of combustion originating in the upper rear of the furnace. Also due to the location of the heating elements, the furnace may be heated more uniformly as compared to a not uncommon variation of 100 or 200 degress in different parts of a batch type oven, particularly near the door. Hence, while pots in the rear of such ovens may be at a temperature sufficient to allow the desired reactions to take place, those near the door or in other portions may be at too low a temperature. Therefore, sufficicient additional time must be allowed for the coolest parts of the oven to attain the necessary temperature.

When pots and packing material are used it is not unusual to observe a lag of from 15 to 20 hours or between the pot and the furnace temperature. Hence, where those can be eliminated, an appreciable reduction of time may be made. Another feature of the particular type of electrical furnace employed is the elimination of ingress of air from without the furnace. For that reason there undoubtedly will be less tendency for scale formation on the castings as the slight amount of oxygen in the chamber at the beginning of the operation soon is combined with carbon. Also according to Storey, *Transactions*, A.F.A. 1914, at temperatures above 1472 degrees Fahr., the equilibrium between carbon monoxide and carbon dioxide is such that the former is formed in preference to the latter, and where there is a large proportion of carbon monoxide in the furnace atmosphere, decarbonization of hard castings will be prevented.

The short annealing previously described is not the only one being used commercially as the General Electric Co., at its Erie, Pa. plant has been annealing motor ends in approximately 27 hours for some time. The electric furnaces used are quite similar to those described, and the present installation is shown in Fig. 4. The three furnaces are 325 kilowatt each and have a combined capacity of 6 tons. The cycle is somewhat different than that employed in the previously described process, and in brief is as follows:

The castings are heated rapidly to 1800 degrees Fahr., which takes about 11 hours and held at that temperature for 4 hours. The temperature of the castings is reduced to 1364 degrees in about 4 hours, and then to 1346 degrees Fahr. They are held at that temperature for 4 hours, and at the end of that period the temperature is lowered to 1318 degrees Fahr. The castings are held at that temperature for 4 hours, removed and allowed to cool in the air.

The process is checked through the various stages of annealing by examination of test bars included in the heats. The bars are in step-form with the largest section 2 inches square and decreasing in three steps to 1½, 1, and ½-inch square. On completion of the 1346 degree stage, some of the castings are fractured and examined. If the examination shows unsatisfactory annealing, the castings are reheated to 1472 degrees Fahr., and allowed to soak for a short time. The temperature then is reduced to 1364 degrees and follows the cycle described from that point. The additional treatment adds about 15 hours to the cycle.

Control Chemical Composition

It is reported that it seldom is necessary to employ the secondary treatment due to close chemical control of the hard iron. Variations in silicon, phosphorus and sulphur content affect the time required for a satisfactory anneal in the short cycle process, and it has been found that castings made in other foundries than its own, require a longer period than the 27 hours mentioned.

From the foregoing it may be seen that the short cycle anneal for malleable cast iron follows well established rules, and involves a heating up period, holding at maximum temperature, and slow cooling through the critical range. In the short cycle anneal each of the operations is conducted at the optimum point, that is to say, the heating up of the castings is conducted as rapidly as possible, and due to the elimination of pots and packing, the lag between furnace temperature and castings is at a minimum, and the maximum holding temperature is maintained at the highest possible point consistent with obtaining the resulting temper carbon in the proper nodular form. The latter is important as Archer and White, and Schwartz point out, for as the maximum temperature is increased the temper carbon becomes coarser and approaches the form of flake graphite in gray iron.

Uniformity of temperature in all parts of the furnace is essential that

(*Concluded on Page* 58)

Rapid Routine Analysis Eliminates Ingoting of

Brass Scrap Mixtures

By Henry C. Deterding

CONTROL of analysis and production of castings of a definite composition when melting mixed brass scrap are the most difficult problems confronting the nonferrous metallurgist. Charges as large as 2000 pounds often show wide variations from the average. Close competition and other factors may make the use of mixed brass scrap necessary. If the castings produced are required to pass fairly close analytical specifications, the metallurgist is not in an enviable position.

Analysis Must Be Rapid

Several years ago, a large brass foundry encountered the previously mentioned conditions. Due to close competition, it was absolutely essential to hold metal costs to a minimum and at the same time keep the analysis within fairly close limits. Large tonnages of red brass scrap were purchased, melted, and cast into ingot. A battery of furnaces was used exclusively for that purpose. Each lot of ingot was numbered and analyzed. Charges were calculated and melted in the foundry for the castings required using this ingot as a base. Double melting involved a heavy expense but accurate cost records proved that the cost was less than if the ingot had been purchased from a smelter.

Drawing on a background of experience in a steel mill operating basic open-hearth furnaces for melting steel, the possibility that a similar practice in melting nonferrous mixtures might be developed seemed plausible. In the operation of an open-hearth furnace, samples of molten metal are taken before tapping and sent to the laboratory as preliminary or *quick* tests. Those samples are subjected to rapid methods of analysis and from the results obtained the melter makes the necessary additions to give the bath the desired composition.

Any brass foundry with sufficient furnace capacity could eliminate the ingoting of red brass scrap charges if a method of analysis and control could be devised that would be rapid enough to make *quick* tests possible. The basic idea was to melt the scrap in the foundry furnaces, draw a sample for analysis, make the required additions as determined by the analysis and pour the metal directly into castings. A study of furnace operations showed that a period of 20 to 30 minutes was required to bring the metal to the proper casting temperature after the charge was melted. This relatively short period was insufficient to make the required analysis, if methods known to the author at that time were used. After considerable experimental work, a rapid and sufficiently accurate method of analysis was devised.

A survey of the analysis of the scrap previously ingoted furnished a working average of the various classes of scrap used. Charges were made up of copper, red brass scrap, rod turnings, etc. Liberal allowances were made in calculations so that the resultant mixture would be on the high side of the required copper content and any deficiencies would occur in the white metal constituents. Sufficient stock also was added to compensate for furnace loss. Experienced sorters inspected the scrap as charges were made up and any aluminum bronze and pieces of iron were discarded. At times, a melt showed the presence of aluminum but that usually was removed readily by furnace manipulation and treatment with copper oxide or lithrage.

Tests Are Taken

Charges were placed directly in oil-fired furnaces. When the charge was melted entirely, the oil was shut off, the metal was stirred vigorously to insure uniformity and a sample was poured in an iron chill mold and sent to the laboratory accompanied by a card indicating the furnace and melt number. Heating of the charge then was resumed to bring the melt to casting temperature.

When the sample arrived at the laboratory, it immediately was drilled and divided between two laboratory assistants. These men were not trained chemists but had been instructed in the particular routine procedure and had developed a high degree of speed and accuracy. Determinations were made for copper, tin and lead. Zinc was assumed to be the remainder.

One man determined the copper as follows: Weigh 1 gram of drillings and place in a 180 cubic centimeter Erlenmeyer flask. Dissolve the drillings in 20 cubic centimeters of nitric acid. Boil to expel nitrous oxide fumes and add 50 cubic centimeters of hot water. After a short boil, cool the sample and make alkaline with sodium hydroxide. Make the solution slightly acid by the addition of acetic acid and bring to a short boil. This last boil is important as it seems to sharpen the endpoint in the subsequent titration. After boiling, cool the flask and its contents, wash into a 600 cubic centimeter beaker and dilute to approximately 300 cubic centimeters with cold, distilled water. Add 7 grams of potassium iodide in solution and begin titration with sodium thiosulphate.

Determines Two Elements

After the bulk of the iodine has been consumed, add starch and carry the titration to the endpoint as evidenced by a change in color from a purple to yellow or white. In the presence of lead, a sharper endpoint is obtained by the addition of a few cubic centimeters of 5 per cent solution of silver nitrate at the time the starch is added. It will be found most convenient to have the standard sodium thiosulphate solution of such strength that 1 cubic centimeter equals 1 per cent copper. A 100 cubic centimeter capacity bruette is recommended for titration purposes.

The second chemist determines tin and lead as follows: Weigh out 1 gram of drillings and place in a 300-cubic centimeter beaker. Dissolve the sample in nitric acid. Add 50 cubic centimeters of hot water and boil for a short time. Filter off the precipitated metastannic acid through an alundum crucible of medium porosity. A crucible holder of either the Spencer or Sargent type, with a water aspirator and filter flask is used. Wash the precipitate thor-

oughly with hot water acidified with nitric acid. After washing, place the crucible in a heavy duty electric muffle furnace for ignition to tin oxide.

Pour the filtrate from the suction flask into the original 300 cubic centimeter beaker. Make the solution slightly ammoniacal with ammonium hydroxide. Heat the solution to boiling and acidify with acetic acid. Continue boiling for a few minute and then add about 30 cubic centimeters of a saturated solution of potassium dichromate. Following the precipitation of the lead as lead chromate, boil the solution for exactly 3 minutes. Chill the beaker with its contents in a pan of ice water to promote the formation of an easily filtered precipitate. Filter off the precipitate of lead chromate on a mat of asbestos fiber in a Gooch crucible and wash free of dichromate with a 5 per cent solution of acetic acid. After washing, transfer the crucible and its contents to a beaker and add 30 cubic centimeters of a 15 per cent solution of hydrochloric acid. When the reaction is completed, add 150 cubic centimeters of distilled water, 3 grams of potassium iodide and titrate the liberated iodine with sodium thiosulphate. An alternative method of titrating the liberated chromic acid is the use of a standardized solution of ferrous sulphate using diphenylamine as an indicator. It is recommended that either solution used be of such a value that 1 cubic centimeter equals 0.50 per cent lead.

After completing the analysis, the required additions were calculated to bring the charge to the desired composition, written on the card that originally accompanied the test and the report returned to the melter. He weighed up the amounts indicated, added them to the metal, stirred the bath and poured off. Due to the fact that the metals added were of low melting points, little delay was experienced by additions.

By proper training and co-ordination of the two quick test men, the analysis can be made in less than 25 minutes. The chemist making the copper determination finishes first, removes the crucible from the muffle furnace and completes that part of the routine. By using a large heavy duty type electric furnace, the alundum crucible and its contents are brought to a cherry red in a short time. A number of dessicators are supplied. Each contains a large aluminum block bored so that the crucible fits snugly in the hole and thus promotes rapid cooling. All crucibles are weighed at odd times and their weights recorded. Crucibles weighing much below the average of the lot are discarded as it usually was found that they did not retain the precipitate well. A chainomatic balance facilitated rapid and accurate weighing. To insure accuracy, each step of the analysis must be definitely standardized both as to time and technique. This applies particularly to the determination of lead as lead chromate. Standard samples of brass of known composition are used in establishing the factors of the volumetric solutions used.

Graphs were made one ordinate of which represented cubic centimeters of sodium thiosulphate solution or milligrams of tin oxide and the other ordinate read percentage of the element sought. A second graph gave the pounds to be added to the charge. These two may be combined in one graph.

The method of control described has been used by the author with good success. Furnaces used must have a capacity of 1500 pounds or more and the tonnage large enough to warrant the technical organization required. It is not practical for the small foundry.

Casts and Machines a 138-Ton Gear

Steel companies constantly are re-equipping their plants with larger and more modern machinery and much of the equipment is of massive size, built to withstand severe service requirements. The constant process of modernization within the steel industry has been beneficial to the foundry industry because, the latter supplies castings for a majority of the new and heavier machinery.

From time to time, operations involved in the manufacture of a large casting have been described in THE FOUNDRY. In these descriptions, the casting either is made in one piece or in several segments. The latter method recently was utilized for the production of a 138-ton gear for a steel mill in the Chicago district by the United Engineering & Foundry Co., Youngstown, O. The gear is 21 feet 4 inches in diameter and is built in nine sections. Two rims of four sections each are bolted to a center spider. All joints are machined within limits of 0.003-inch before being keyed and bolted together. The gear has 268 teeth for which the maximum error in spacing was 0.008-inch.

Control Governs Anneal

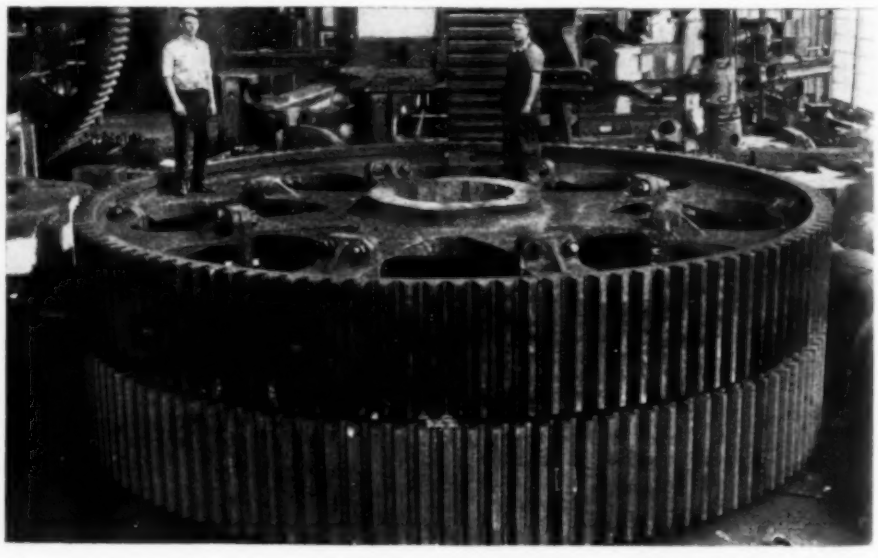
(*Concluded from Page* 56)

all castings attain maximum temperature in minimum time. Holding at maximum temperature is reduced as far as is consistent with the assurance of having all the carbon in solution. From the maximum holding temperature to the critical range, the temperature is reduced as rapidly as possible, and the castings are cooled through the critical range at a rate that will allow the remaining combined carbon to be decomposed into temper carbon and ferrite.

Chemical composition also has considerable effect upon the possibility of shortening the annealing cycle. To attain the shortest possible cycle it is necessary to use hard iron containing the maximum silicon and carbon consistent with the desired physical properties. The limiting factors are the tendency of high total carbon to weaken the ferrite matrix, and of high silicon to promote primary graphitization. Storey states "the higher the percentage of silicon present, the higher the temperature below which carbon and iron may be entirely decomposed. This means that by increasing the silicon content of malleable iron, the easier will be the breakdown of the iron carbide. The amount of silicon, of course, is limited by the tendency to form gray iron."

This is the second and concluding article on the shortening of malleable cast iron annealing cycles. The first appeared in the Aug. 15 issue of THE FOUNDRY.

THE EDITORS.



Many Large Castings Are Required for the Construction of Large Pieces of Steel Mill Equipment

The FOUNDRY Family Photograph Album

Upper Left

KENNETH JENSEN

Kensington Steel Co., Chicago

Upper Right

GEORGE ALTEN

Alten's Foundry & Machine Works, Lancaster, O.

Lower Left

CARL H. HOFFSTETTER

Odin Stove Mfg. Co., Erie, Pa.

Lower Right

E. S. CARMAN

Edwin S. Carman Inc., Cleveland

TENTATIVE RECOMMENDED PRACTICE FOR

Copper 80, Tin 10, Lead 10 Alloy

Development and Field of Use

The 80 copper, 10 tin and 10 lead alloy long has been considered a good standard bearing metal. It is an excellent wearing material under conditions of high speed, heavy pressure, shock and vibration. Its resistance to corrosion is good as compared to most of the other alloys not especially designed to meet this requirement.

Chemical Control

The chemical composition of the metal intended for use should be known, as the presence of elements other than copper,

Physical Properties For Sand Castings

Ultimate tensile strength, pounds per sq. in.	26,000-33,000
Proportional limit in tension, pounds per sq. in.	9,500-11,500
Yield point in tension, pounds per sq. in.	18,500-20,000
Elongation in tension, per cent (in 2 in.)	6-8
Reduction in area, per cent	5.6-7.4
Compression of 0.001-in. (on cylinder ½-in. square cross section and 1 in. high) at	13,500-15,000 lbs.
Compression of 0.1-in. (on cylinder ½-in. square cross section at 1 in. high) at	45,000-47,000 lbs.
Compression of 0.27-in. to 0.30-in. (on cylinder ½-in. square cross section and 1 in. high) at	100,000 lbs.
Brinell hardness number	61-70
Pattern maker's shrinkage, inches per ft.	3/16
Specific gravity	8.9
Weight per cubic inch in pounds	0.322
Resistance to impact (Izod test), ft. lbs.	3-8

tin and lead in this alloy changes its melting point, freezing range, shrinkage, physical properties and pouring temperature. For instance, the tensile strength can be made to vary from 22,000 pounds per square inch to 34,000 pounds per square inch, the elongation from 8 to 14 per cent, and the hardness from 45 to 65 brinell (500 kg.), as the result of different ingredients or impurities being present.

Abstracted from a report of the committee on recommended practices of the nonferrous division of the American Foundrymen's association presented at the annual meeting held in Chicago, May 4 to 7, 1931.

(*Continued on Data Sheet No. 876*)

TENTATIVE RECOMMENDED PRACTICE FOR

Copper 80, Tin 10, Lead 10 Alloy

(*Continued from Data Sheet No. 875*)

Sand

Sand for this alloy will give best results when sand having the characteristic of about No. 0 to No. 1 Albany grade is used for the lighter-sectioned castings, and when No. 4 to No. 6 with a graphite coating is used for the heavier-sectioned castings. The coarse grade of sand will help to eliminate cutting and scabbing.

Cores

Cores for this alloy should be made of a fine silica sand and painted or dipped in graphite paint as this alloy has a great ability to penetrate dried sand.

Gating and Heading

Simple brass or bronze gating can be used for this alloy, except that some kind of a skimmer should be used in the gate to hold back the phosphorus slag, which is common to this type of alloy.

Heading of castings made of this alloy is controlled by the phosphorus content and, where there is sufficient phosphorus present, the elevated gate will serve as the head; but where the phosphorus content is low and the zinc is high, a blind head is preferred.

Cleaning Castings

Gates and heads can be nicked and broken off. The castings can be cleaned best by the sandblast rumbling method.

Chilling

This alloy is one of the bronze alloys that permits improvement easily by the chilling process. Chilling gives a fine grain structure and tends to increase the physical qualities for the better, with the exception of ductility.

(*Continued on Data Sheet No. 877*)

The Foundry Data Sheet, Sept. 1, 1931

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Sand Condition
Is Important in the Steel Foundry

By John Howe Hall

PROGRESS in steel foundry molding methods among other things has included the installation of sand reclaiming systems, and the use of colloidal clays which have a high degree of *stickiness* as bonding agents. With the advent of those developments, many foundrymen, especially those who are relatively newcomers to the steel foundry industry, often are moved to inquire whether heap sand can be reused without being reclaimed, and what advantages are possessed by colloidal clays such as bentonite.

In foundries producing both green and dry-sand molds, the question often arises whether the same facing sand may be used for both. Mixtures for making hard and soft cores and the applications of such cores are frequently discussed. Other problems that the steel foundrymen are concerned with is the amount of old sand that can be used on castings of a given weight, say 200 pounds, and what are the causes and remedies for scabs on steel castings. Since the problems mentioned are of interest, a brief discussion of them may aid in overcoming some of the difficulties encountered in the steel foundry.

Use Facing Sands

In plants that do not have a sand reclaiming or sand cleaning system, it is generally the practice to use a facing sand mixture to put next to the pattern, and fill the flasks with heap sand from the floor. The facing mixtures are made up of part old sand, part new sand, and binders. There is, of course, a steady accumulation of dust and fines in the sand, which consists of burned-out clay from cores and facing, sand grains that have been broken up by the heat of the steel, etc. At the same time, the binder used is likely to build up too high a proportion, as it is difficult to know exactly how much to add to each batch of sand mixed to take care of the new sand and of the portion of the old sand whose binder has been burned out.

Accumulation of fine, inert material in the sand, and the difficulty of putting back just the proper amount of binder make it impossible to use all old sand in the facings for any length of time. By adding a certain proportion of new sand to each batch, and removing from the foundry at regular intervals enough of the accumulation to balance the amount added, the sand can be kept in proper condition. In fact, until recently this was the universal practice in steel foundries; it was succeeded by the present sand reclaiming systems, first—because of the difficulty of keeping the heaps properly compounded under the old method; and second—because with a good sand reclaiming outfit it is possible to get along with much less new sand.

Under the old system the amount of new sand used in facing mixtures for castings weighing 200 pounds varied from one part new to six parts old, to four parts new and one part old; some few concerns used all new sand in their facings, the heap being used only to fill the flasks. A fair average would probably be one part new to three parts old sand.

Metal Is at a High Temperature coming from the Furnace

Green sand facings should in general be as open as possible, to allow the steam from the water in the sand, and the gases due to the effect of heat on the binders, to escape freely to the vents and to the outside of the mold, instead of being trapped in the steel and giving rise to pin holes. If the sand is too *close* the sudden generation of steam and gas, under the skin of a hard rammed green sand mold, is likely to blow off a portion of the facing sand, giving rise to a scab. The same thing is true of dry sand molds in which considerable amounts of organic binder are used, or of dry sand molds that have not been throughly dried, leaving water in the sand close to the casting. Patches on dry sand molds, in which water has been applied too freely without drying it out, are another prolific source of scabs.

Sand May Be Weak

At the same time a green sand facing must not be too *open*, or it will be so weak that the flowing metal will cut it away as the mold is filled, causing a wash at the point where the sand was cut out, and probably a lot of sand holes and dirty spots in the surface of the casting at the point where the dislodged sand came to rest.

The best green sand facings generally are supposed to be made of a good grade of sand, containing at least 97 per cent silica with as uniform a grain size as possible. In some localities such a sand is obtainable in the condition in which it is dug from the banks; in other places it is washed and sized to remove excess fines and to increase the uniformity of grain size. This is mixed with enough binder to give it the requisite strength, without so filling up the spaces between the grains as to make the sand too dense. The greater the ability of the binder to hold the grains of sand together, the less of it can be used to obtain a given strength and the less it will close up the sand. Clays are generally used as binder, reinforced by

some of the many kinds of sticky substance sold for this purpose, such as molasses, glutrin, pitch compounds flour, etc. Because of the fact that their stickiness, so to speak, is much greater than that of ordinary clays, the bentonites are used largely in place of other clay in green sand facings. They allow the sand to be made strong without being too close.

A good green sand facing can be made of 75 to 90 parts of sand (mixed one of new to three of old) with one part bentonite and a small amount of some commercial pitch binder. The exact amount of the clay and binder has to be varied to suit the particular requirements of the shop, and must be ascertained by experiment.

One of the most satisfactory mamterials for dry sand facings are the naturally bonded molding sands, containing about 90 to 94 per cent silica, which can be obtained from sand dealers anywhere. These sands contain about the right amount of clay to give them the necessary strength, in the condition in which they are dug, so that they need little binder. As they are supposed to be thoroughly dry when steel is poured against them, openness is not so necessary as in green sand work. One part of a pitch binder in 70 to 90 parts of sand of this type (mixed three parts old to one part new) will give good results.

Guard Against Contamination

Care should be taken that the green sand mixtures do not become contaminated with large proportions of old sand from these dry sand mixtures, or trouble will be experienced with the green sand becoming too dense. When sized round grain sands are used for green sand work, and it is desired to use the same sand for dry sand facings, it is more difficult to secure proper strength in the dry sand without using so much clay and binder as to render it altogether too dense, with the resulting crop of pin holes and scabs. Foundries trying to solve this problem are working along the line of using clays of the maximum bonding power, reinforced by some of the organic binders.

Soft cores are generally made of all new sand, bonded with clays, oil, or some of the organic sticky substances used for facing sands. When oil alone is used, a good proportion is 50 to 90 parts sand and one part oil. Oil sands are quite strong when properly baked, and can be handled freely without breaking, but the heat of the steel burns the dried oil out rapidly, causing the core to lose its strength and to offer little or no resistance to the shrinkage of the steel around it. Such cores are *soft* cores because they stand up only long enough to allow the steel to set around them, and then become soft.

A *hard* core is produced by using clay and binder freely, so that the core is strong when dried, and retains its strength longer when the steel is poured around it. Care has to be taken, of course, to see that it is not so hard as to crack the steel around it as the casting cools. A good mixture for a hard core can be made with 35 parts sand, two parts clay, and one part pitch binder. A large proportion of the sand can be heap—in fact, some shops use all heap sand for hard cores. The cores after drying should be well washed with a mixture of silica flour, water, and molasses or other binder, and the coating should be thoroughly dried before the cores are used.

When a small core is to be surrounded by heavy sections of metal, it has to be made tight, and washed heavily with an impervious coating to prevent the steel penerating between the grains of sand. A good mixture for such a core is 40 parts sand, two parts silica flour, and one part linseed oil or an equivalent quantity of a good linseed base core oil. Dry thoroughly and wash several times with a mixture of silica flour and linseed oil, drying each coat of wash as applied. The silica flour in the sand mixture is for the purpose of closing up the grain of the sand to prevent the penetration of steel into the core.

Reviewing New Books

Worth While Literature Covering Numerous Problems Pertaining To Foundry Practice, Management, Merchandising and Research

Promotes Understanding

Organization Engineering, by Henry S. Dennison, cloth, 5 x 7 inches, 204 pages, published by the McGraw-Hill Book Co., New York, and supplied by THE FOUNDRY, Penton building, Cleveland, for $2.00 plus 15 cents postage and in London by the Penton Publishing Co. Ltd., Caxton House, Westminster, for 5s., postage extra.

In defining organization engineering, the author states, "Men are living together and working together in organized groups more and more each year. The increase of populations, the improvements in intercommunication, and the fast growing intricacies of the political, industrial and commercial worlds, have brought into the foreground of importance the problems of making a success of group life. The task of facing these problems definitely and consciously, and of analyzing and making progress in solving them, is here considered the task of organization engineering."

The first section of the book deals with the problems of men working in groups. It discusses the various motives that make men work and their reactions to different methods of handling; it explains what causes friction among groups and how it may be eliminated and team-work promoted. The function of leadership in an organization and how to impell workers to greater efforts also are discussed. The second chapter deals with the reasons for men taking an interest in their work. It explains the self-improvement motives such as pay increases, promotion, craftsmanship, higher social plane and loyalty and tells how it is possible to stimulate them. Another section deals with direction, training and education of the personnel of an organization.

Various phases of the structure of an organization are discussed in the last chapter which deals with the close study that must accompany the organization of the directing staff of a company and tells some of the characteristics that should be embodied in them. It discusses the need for both internal and external co-ordination. The book as a whole deals with the psychological side of business organization.

Discusses Seasonal Business

Reducing Seasonal Unemployment, by Edwin S. Smith, 296 pages, 6 x 9 inches, cloth, published by the McGraw-Hill Book Co., New York and supplied by THE FOUNDRY, Cleveland, for $3.00 plus 15c postage and in London from the Penton Publishing Co., Ltd., Caxton House, Westminster for 15s postage extra.

The problem of seasonal fluctuation in the rate of business activity and consequent losses to the employer as well as to the employee is given a broad, general survey by the author. The study was made under the sponsorship of the committee to study methods of reducing seasonal slumps. This committee composed of prominent business men aided materially in the investigation.

Need for reducing seasonal slumps and the causes are considered in relation to the proper steps to be taken to reduce the adverse effects. Among the remedies discussed are: pushing sales in the dull season, creating out-of season uses for the seasonal product, diversifying the market and the product, ordering, and budgetary control methods. Stabilizing employment for the individual worker also is considered. The work brings together the conclusions of a great many industries and outlines the methods and practical results obtained by various companies

in following methods for reducing the seasonal slumps. This experience of other concerns as assembled in the book is a valuable guide to the business man or manufacturer who wishes to correct seasonality in his own business.

Writes Autobiography

Autobiography of an Engineer, by William L. Emmet, cloth 6 x 8 inches, 213 pages, published by Fort Orange Press, Albany, N. Y., and supplied by THE FOUNDRY for $2.00 plus 15.00c postage and in London by the Penton Publishing Co., Ltd., Caxton House, Westminster, for 10s postage extra.

A leading part in at least four important phases of electrical development has been taken by the author during his 45 years of activity. These include the central station electric industry, steam turbine apparatus, electric ship propulsion, and mercury power systems. The autobiography of the life work of Mr. Emmet is particularly interesting to the reader with engineering inclinations because an intimate contact is established with a period of enormous development in the electrical industry.

It is refreshing to read the experiences of an engineer who admits he knows little of higher mathematics. The author expresses the opinion that the best engineers depend on proportional thinking with a thorough knowledge of the details of the job rather than on mathematical calculations. Mr. Emmet never calculated in his head the design of a dynamo, but when street railways would not run he was the man on the job who reinsulated the windings to keep out the water. He does not minimize the work of the theoretical engineer, but he states the case of the practical man in a frankly egotistical manner that makes interesting reading.

Studies Commercial Irons

Gmelins Handbuch der Anorganischen Chemie, Eisen, Teil A, Lieferung 3, paper, 274 pages, 6¾ x 10 inches, published by Verlag Chemie, Berlin, Germany, and supplied by THE FOUNDRY, Cleveland, for $9.50, plus 15 cents postage.

This volume is a continuation of Part A on Iron of Gmelins *Handbook of Inorganic Chemistry*. Previous sections dealt with the historical phases of iron, location of iron deposits throughout the world, pure iron, iron and rare gases, iron and hydrogen, iron and oxygen iron and nitrogen, iron and oxygen, iron and nitrogen, chlorine.

The present volume discusses the passivity of pure and commercial irons; passivifying iron through chemical, electrolytic and ionization means, and the activation of passive iron. The second chapter deals with the chemical behavior of corrosion of pure and commercial irons. The third chapter on the recovery of commercial iron is divided into two parts dealing with its recovery as pig iron and as forgeable iron.

A Correction

The price in London of *Spectrum Analysis in Mineralogy*, by A. A. Fitch, was given as 7s 9d in the July 1 issue, due to a typographical error. The correct price is 1s 9d net or 1s 11d, post free.

Railroad Uses Malleable Side Stakes

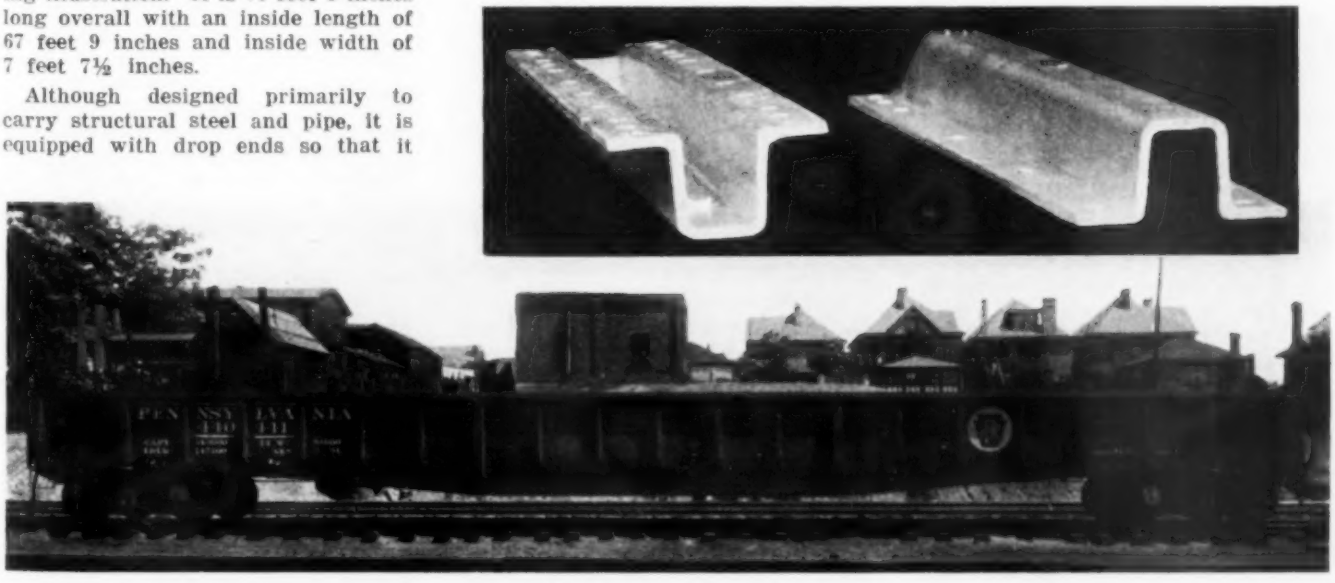
LAST winter the Pennsylvania railroad authorized the building of 1500 large gondola cars at a total expenditure of $5,000,000 and in so doing provided direct employment for 600 of its employes in its three shops at Altoona, Enola and Pitcairn. Construction of these cars required 41,500 gross tons of steel and steel products, representing considerable indirect employment.

These cars, known as the G-26 gondola, are of special interest because of their type and large size. One of the cars is shown in the accompanying illustration. It is 70 feet 3 inches long overall with an inside length of 67 feet 9 inches and inside width of 7 feet 7½ inches.

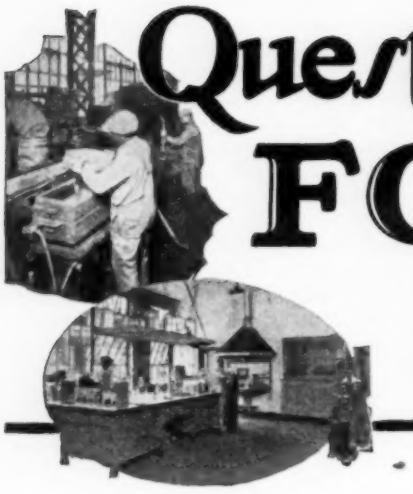
Although designed primarily to carry structural steel and pipe, it is equipped with drop ends so that it may be used for open shipment of automobiles. The car itself weighs 62,000 pounds and is built to accommodate a normal load of 140,000 pounds with a limit of 148,000 pounds carrying capacity.

One of the features of construction is the use of high-strength malleable castings for side stakes. To obtain a corrosion-resistant material for this purpose which would be uniformly strong and rigid and without excessive weight, the builder specified that the malleable iron should have a minimum yield point of 35,000 pounds per square inch and an elongation of 18 per cent. The engineers specified only the properties which would insure maximum quality of the material to be used.

A total of 2600 tons of malleable iron comprising 57,000 pieces was ordered from four foundries. A record compiled from all the heats cast shows an average yield point of 37,927 pounds and an elongation of 23.1 per cent. The average ultimate tensile strength was 57,600 pounds. Some of the stakes were punched while in others the holes were cored.



Gondolas Built by the Pennsylvania Railroad During the Past Winter Required the Use of 2600 Tons of Malleable Cast Iron Side Stakes Comprising 57,000 Pieces



Questions & Answers on FOUNDRY PRACTICE

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

GRAY IRON

Melt Iron Continuously

Do you know of any gray iron foundry running a continuous heat under the following conditions: Heat runs from 10 to 18 tons per day and the number of molders is 10 or 12? In a shop of this kind do the molders pour the metal or is it handled by a separate gang?

We do not know of any gray iron foundry running continuously on daily heats between 10 and 18 tons, but practically all malleable foundries run two heats a day and in the nonferrous foundries the practice of continuous pouring is universal. No practical reason exists to prevent gray iron foundries from operating under the same conditions. All the large production gray iron foundries operate in this manner. The main reason up the present that the small shops do not operate in a similar manner is that it has not been necessary. Ample floor space has been provided to take care of the daily output of molds before the iron is melted and distributed.

Q & A

Compositions Differ

We are engaged in the manufacture of a line of white iron shell liners, impellers and plates for use in slimes and sand pumps for the local gold mines in South Africa. A 10-inch sludge pump has a case liner 3 feet 5½ inches in diameter; the impeller or runner is 1-foot 9 inches in diameter, and the cover liner is 2 feet 4¾ inches in diameter. Metal thickness of those castings is about 1¼ inches. Can you give us any information on suitable analytical limits to work to which will insure maximum life?

Inquiry on the subject of suitable analysis for sludge pump work gives the following information: One prominent metallurgist states that local conditions and local irons will affect the material best suited for the purpose. In this country the analysis would show the following range: Silicon, 0.50 to 0.60 per cent; sulphur, below 0.10 per cent; phosphorus, 0.30 per cent, and manganese, 0.50 per cent. The exact hardness would have to be determined by chill blocks cast from the ladles to be used, and would be largely a matter of experiment for the first few castings. Any possible machine work will affect the hardness of the iron possible to use.

A superintendent associated with a firm which makes many castings like those mentioned states that different engineers specify and use a variety of analyses. At present a high test iron made from 75 to 95 per cent steel in the mixture is used for slush and sand pumps. Silicon is added to give machinable castings according to the thickness of metal. Silicon runs about 2 per cent; sulphur, under 0.10 per cent; manganese, 0.80 per cent; phosphorus, under 0.20 per cent, and total carbon around 3.0 per cent. The idea is to keep silicon as low as possible considering section in the casting and still be machinable. Where no machining is required the silicon can be reduced still further Several pump builders are casting liners in a chill with good results. The thickness of the chill varies according to metal section. He stated that he has cast some sand and slush pump work with low silicon mix to give a white iron, but experienced trouble due to cracking in the foundry, and in service.

Another foundry superintendent states that his firm found it necessary when extra hard service was involved especially with abrasive action, that manganese steel be employed. Other impellers made by the firm were cast from two mixtures. One contained 1.80 to 2.00 per cent silicon; sulphur, as low as possible; phosphorus, 0.30 per cent or under, and manganese, 2.00 to 2.25 per cent. The other contained 1.50 to 1.75 per cent silicon; phosphorus, 0.30 or under, and manganese, 1.25 to 1.75 per cent. The mixtures from which the irons were made contained from 40 to 50 per cent steel scrap.

Q & A

Alloys with Vanadium

We have a customer for whom we have been making automobile dies of gray iron and semisteel as well as from nickel-chromium iron. Recently a contract was received for some new dies and the specifications call for vanadium-iron. We would like to have some information on what type of mixture should be employed including the amounts of pig iron, gray iron scrap, steel, and vanadium; also whether the vanadium is added in the cupola or to the ladle.

Vanadium may be added to your mixture either by the employment of pig iron that contains that element or by adding ferrovanadium to the ladle of molten iron. It is claimed that additions of vanadium increase the strength and wearing qualities of gray iron. Additions of vanadium usually range from 0.15 to 0.20 per

cent, and often small additions of nickel, chromium and molybdenum are made in conjunction with vanadium.

One foundry engaged in making fender dies uses from 15 to 25 per cent steel in the mixture, and the silicon ranges from 1.25 to 1.75 per cent. Since you have had considerable experience in making such dies, you should have no difficulty in developing a suitable mixture. In fact we are inclined to suggest that you make the addition of 0.15 per cent vanadium as powdered 33 to 35 per cent ferrovanadium to one of your present unalloyed gray iron mixtures. You also might try the vanadium addition to your nickel-chromium mixture to see what effect it has.

GENERAL

Sand May Contain Acid

Can you tell us whether sand extracted from a 2 per cent sulphuric acid bath, and then washed three times through clear water, would be likely to contain sufficient sulphuric acid to damage steam pipes during the process of drying?

If the sand is practically all silica, that is to say contains little if any clay or silt, the amount of acid retained in the sand probably will be quite small, and will have little effect on the steam pipes. However, if much clay or silt is present, considerable quantities of acid may be retained in that colloidal material as it usually is difficult to wash.

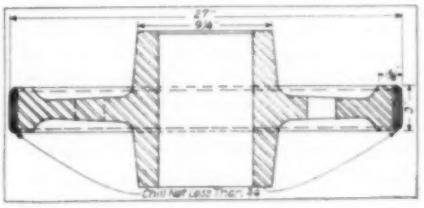
To ascertain in a qualitative way, the efficacy of washing, weigh out 25 grams of the moist sand into a beaker. Cover it with 100 cubic centimeters of distilled water. Add hydrochloric acid until the mixture is just acid, and heat to the boiling point. Filter through a paper catching the filtrate in a clean beaker. Wash the sand and paper in the funnel several times with hot distilled water. While the solution is still hot, add 10 cubic centimeters of a 10 per cent barium chloride solution. The white precipitate of barium sulphate which forms after standing for sometime, is an indication of the amount of sulphuric acid remaining in the sand.

Q & A

Chilled Rollers Crack

We are having trouble with chill checks on the narrow face of a gate roller, 27 inches diameter. When we use all car wheel scrap to get the ¾-inch chill desired we find a chill check or several checks on the face. With a softer iron, a mixture of car wheel scrap and pig iron, we find no chill checks, but the depth of chill is not sufficient to meet specifications. The chiller is 3½ inches thick. Metal is poured through four pop gates on the hub and fills the mold in 12 seconds. The molds are made carefully and leveled on the floor. We have tried an all scrap charge with the silicon raised in the ladle by the addition of ferrosilicon. We have raised the manganese in the same manner by the addition of ferromanganese, but without beneficial result. To test out a theory that the casting is ill-proportioned we stopped off the hub and part of the web on one wheel. The rim was chilled to a depth of 1 inch and showed no sign of chill crack. A whole wheel poured from the same ladle of iron showed two checks on the rim.

A question similar in general features to the foregoing was considered rather fully on page 69, Feb. 15 issue of THE FOUNDRY and we suggest that you study that article. Your theory of ill proportion between hub and rim is plausible in the present instance. We suggest you strip the core from



Chill Checks Appear on the Face of the Roller

the hub immediately after the metal has set. If necessary, hasten the cooling by pouring water into the cavity. This treatment will help to equalize the cooling speed of hub and rim.

Q & A

Melts Cast Borings

At our plant we have a considerable amount of short steel shavings and cast iron borings. We are anxious to use this material in the cupola for the production of castings that require no machining. We shall appreciate information on the following points: 1—In what form are these materials placed in the cupola. 2—Have cast iron borings and steel turnings been melted successfully without briqueting or loading in cans. 3—What is the estimated loss in melting these materials in the manner described in question No. 2. 4—How are these materials usually charged. Is it necessary to use other materials in conjunction with this scrap to insure maximum melting results. 5—What ill effect, if any, does the melting of steel turnings have on the life of the cupola lining.

Taking up the various items in the order of presentation, 1—Borings and turnings are charged according to two principal methods. In one the material is compressed into briquets under hydraulic pressure in an automatic machine that delivers little blocks so long as the material flows into a feeding hopper. The usual weight of a briquet is 7 pounds, diameter 4 inches and thickness 3 inches. In the second method, the material is packed into sheet metal containers, length of stove pipe, mounted either on a jolt machine or packed by hand. A small sheet steel disk seals each end of the pipe and is held in place by crimping the end of the pipe with a hammer.

2—Borings and turnings cannot be melted successfully or economically by shoveling them indiscriminately into the cupola. A small part of the total amount will melt, but the greater part will oxidize and disappear. 3—Accurate figures on this item are not available, but practical foundrymen are satisfied that the loss is approximately 90 per cent.

4—The fact that the most prominent users of briquets are the large automobile companies explains the use of pig iron as part of the charge. The briquets merely represent a part of the scrap which enters into the complete charge. Under other conditions, no barrier exists to prevent the use of 100 per cent charges made up of borings or turnings. 5—Melting steel turnings in moderation, say up to 20 or 25 per cent of the total charge, will not affect the cupola lining any more adversely than melting any other form of mixture containing a similar percentage of steel scrap.

MALLEABLE

Iron Not at Fault

We are manufacturing malleable tube (pipe) fittings and are using the white heart process similar to that used in Germany. However, we are experiencing some difficulty in getting a sound casting. Porosity occurs at the end of the fitting where the band or bead is. We have checked over our melting process which is by cupola, and have tried various analyses of iron without results. On the small fittings such as ⅛-inch and ¼-inch we have no difficulty, and with the ⅛-inch size can guarantee every one being sound. However, as the size increases so does the porosity, until we get to the 2-inch size where it is difficult to get a sound castings at all. The hard iron analysis shows 3.30 per cent total carbon; 0.62 per cent silicon; 0.14 per cent sulphur; 0.058 per cent phosphorus, and 0.12 per cent manganese.

It appears to us that your difficulty is due primarily to a matter of gating, feeding, and pouring temperature. To obtain pressure tight castings it will be necessary to have a good head of metal, and comparatively heavy shrink bobs. In fact with fittings to withstand high pressures, it often is necessary to gate from both sides and use heavy shrink bobs; the gates and bobs containing considerably more metal than the castings themselves. If you now are using a shallow cope, it is suggested that you try a deeper one that will increase the head of metal. Also try changes of gating and variation in pouring temperature.

Problems in Nonferrous Founding

By Charles Vickers

Furnaces Melt Slow

At present we are operating a battery of 10 furnaces for brass melting. The copper content of the metal is 75 to 85 per cent and both scrap brass and ingot metal are used. Coke sides and coal bottoms are used in the furnaces, and we find that we can only get out about thirty-two No. 60 pots whereas we need about 40.

While you have not included the information in your inquiry, we assume that the furnaces are natural draft type. Blast or forced draft furnaces ought to melt 5 heats per day figuring conservatively, but you should obtain 4 heats a day with the present furnaces. It may be that some slight changes may be necessary to obtain better efficiency in melting. The first thing to examine is the height of your stack. It should be at least 45 feet high, and must be higher than any nearby building. If your stack meets those conditions, the next thing is to consider the sizes of the individual flues and the breeching connecting the flues with the stack.

Each fire should have a flue opening about 6 x 8 inches opening into the main flue to the stack. It may be made of cast iron about ½-inch thick which is slotted to admit a sliding sheet metal gate. The gate can be closed when the fire is not in operation. The next thing to determine is the proper size of the stack and the main flue. Figure the area of all the flues which in this case is 6 x 8 x 10 or 480 square inches. Multiply that by 2 which gives the desired area of the stack or 960 square inches. If a square stack is used it should be 31 inches on a side in the interior, and if round which is more likely, it should be approximately 18 inches in diameter. From the size of the stack you can determine the size of the main flue which should be about 25 per cent less in area or 720 square inches. Therefore, a square flue 27 inches on a side should be all right.

An important feature of natural draft furnaces is to have a 2-inch gap between the furnace bottom plate and the grate bars. That will prevent the slag from freezing the bars in place. Also the bars should be at least 1 inch apart. They should not be spaced so far apart that much unburnt fuel drops into the ash pit. Coal bottoms usually slow down melting unless used with forced draft furnaces.

In operating the furnaces, deepeners should be used on the pots to enable the furnaceman to get the whole charge into the pot at one time. The deepeners may be purchased or may be made by chopping off the bottoms of old pots. No coke should be used around the deepener, as it acts mainly as a funnel. Put a few blocks of hardwood on top of the charge. When all the metal has melted down into the pot, and before it gets hot, stir well, and remove the deepener. See that the surface of the metal is covered with charcoal.

Q & A

Use Zinc for Statues

Can you tell us what metal is used in making large statues which imitate bronze? How are they colored?

The metal used for making such statues and monuments is called white bronze, and is a high quality of zinc which is light gray in color. Methods employed in making the castings are similar to those employed for making bronze statuary with the exception that it is a little easier due to the lower melting point of zinc.

Coloring of the statues is a natural finish resulting from the action of the atmosphere upon zinc. With small statuettes and ornaments, the zinc castings sometimes are copper plated and colored to imitate bronze.

Q & A

Have Same Cooling Rate

We would like to learn if there is any difference in cooling time of nonferrous metals brought to 2100 degrees Fahr. in coke-fired and oil-fired furnaces where the heating time in the oil-fired furnace is approximately one-half that required in the coke-fired furnace. We understand that there is a known law in the case of ferrous metals that governs the cooling time, and presume that it will apply in the case of nonferrous metals.

If there is any law, known or otherwise, that governs the cooling time when conditions of temperature, pouring rate, mold, etc. are similar, and the only difference is in the melting unit, we have yet to hear of it. There is a possibility that the cooling rates of the metals may differ due to other conditions such as contamination especially from gases. Since as you describe, the coke-fired furnace will take twice as long to melt the metal as the oil-fired furnace, the chances for the absorption of gases are increased considerably unless the metal is protected properly.

Q & A

Amalgamates Zinc

Can you give us any information on amalgamating zinc with 2 per cent mercury? Is it added to the molten zinc, and if so, will not some of the mercury distil off with injurious effect upon the workmen's health? We manufacture battery zincs of various kinds, and a customer desires zinc with 2 per cent mercury.

Usually zinc battery elements are amalgamated on the surface by rubbing with mercury to prevent rapid destruction of the elements due to impurities in the zinc. That may be accomplished by immersing the plates for a few seconds in a solution containing 1 part of sulphuric acid to 16 parts of water. Then moisten the plates with a solution of corrosive sublimate (bichloride of mercury which is poisonous) and rub on the mercury.

If you desired to alloy the mercury with the zinc, you might try melting the zinc and keep the temperature as low as possible. Zinc melts at 787 degrees Fahr. which is higher than the boiling point of mercury, and of course some of the latter will be volatilized. Carry the melting and pouring operations out in a well ventilated place arranged so that the workmen will not inhale the mercury fumes given off. In adding the mercury, pour it in a thin stream into the molten zinc, and stir well to incorporate it.

Gray Iron Institute Revises Standard Sales Agreement

THE Gray Iron institute, Terminal Tower building, Cleveland, recently revised its standard sales agreement and trade customs to conform to an agreement which its merchandising committee has reached with the National Association of Purchasing Agents, as announced in the May 15 issue of THE FOUNDRY. The revised standard sales agreement, which presents conditions and terms upon which all quotations are made and all castings are sold, is as follows:

1. Unless otherwise agreed, quotations must be accepted and patterns furnished the foundry within thirty (30) days from date of quotation.

2. All castings are sold as rough castings, f.o.b. cars, foundry point. Terms—thirty (30) days net, from invoice date, unless otherwise stated.

3. Claims for error in weight or number must be made within ten (10) days after the receipt of castings.

4. Foundry is responsible for the replacement of castings rejected due to foundry defects and such castings must be reported and returned to the foundry within ninety (90) days after their receipt. Foundry is not responsible for machine work, welding, labor charges or other losses or damages caused by defective castings unless otherwise agreed in writing.

5. Foundry is not responsible for loss of or damage to patterns by fire or other casualties beyond its control.

6. Foundry shall not be liable in damages for failure to deliver as a result of fires, strikes, differences with employes, accidents or other causes beyond its control.

The purpose of the institute in setting forth the following trade customs is to establish between customer and foundry a complete understanding of those conditions peculiar to the gray iron foundry business. The trade customs are as follows:

Revised Standards for Quotations

1. Blue prints submitted for estimating purposes should be marked with rough casting weight, if known, or an estimated weight upon which quotation will be based. A detailed description of the pattern equipment should be furnished.

2. When quotations involve the making of piece prices, definite weights shall be established and agreed upon, and quotations shall be subject to revision on any variation from the established weights.

3. Unless otherwise specified by the foundry, quotations are based on castings with gates, fins and other projections removed to approximately the contour of the pattern.

Orders

4. No order shall be changed unless notice of revision is made and accepted in writing before work is in process. If work is in process, customer is to be charged for any castings made as well as cost of cores, molds or equipment discarded because of such changes.

5. Cancellations of orders are to be made only by mutual consent of buyer and seller.

6. Unless otherwise stipulated, the customer shall accept an overrun of ten per cent above quantities specified on order. However, the foundry is to make an effort at all times to furnish as near the exact quantity specified as operating conditions will permit.

Pouring Molds in a Foundry Equipped with Conveyors

7. If customer requires special production service to secure unusual deliveries, an extra charge shall be made.

Patterns and Core Box Equipment

8. Customer must supply equipment in condition to produce economically the quality and quantity of castings required.

9. An extra charge will be made if patterns require stopping off or if skeleton or sweep pattern equipment is furnished.

10. Foundry is not responsible for variations existing between blue prints and equipment supplied by customer.

11. All patterns, core boxes and loose pieces thereof, should be marked properly for identification.

12. Follow boards, core driers and similar devices when required, are to be furnished by customer.

13. Repairs and changes to patterns by customer's orders will be made at expense of customer.

14. All freight, drayage, boxing and crating charges on patterns, both to and from the foundry, shall be assumed by customer.

15. Pattern storage facilities are provided by foundry for active patterns only. Patterns not in use for a period of six (6) months will be returned to the owner or will be subject to storage charges.

To insure the elimination of error, the following recommendations, agreed to by other outstanding organizations of the foundry trade, are made.

Patterns are to be painted the following standard colors: Unfinished surfaces, black; machined surfaces, red; seats of and for loose pieces, red stripes on yellow background; core prints and loose core print seats, yellow; and stop-offs, diagonal black stripes on yellow base.

The institute recently has published a folder containing the revised standards which may be obtained by addressing the Gray Iron institute, Terminal Tower building, Cleveland.

E. B. Wolf has joined the Detroit sales office of the Dispatch Oven Co., Minneapolis, to assist in the sale of that company's equipment in Eastern Michigan and Northwestern Ohio.

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

INSTEAD of placing a suitable piece of wood or metal in the cope to form the sprue in a small mold, the custom still widely is observed of punching the sprue opening through the sand of the cope with a short length of brass tube varying in diameter from ¾ to 1½ inches. Where the sand is rammed by hand, the molder guesses at the position of the sprue. Where the cope is squeezed on a machine operated by hand or power, a small projection on the face of the squeeze board or head, forms a small depression in the sand and definitely locates the position of the sprue.

Diameter Is Increased

In the great majority of instances the method is quite satisfactory where the sprue opening is formed with a straight length of brass pipe sharpened at the working end. However, in many instances, particularly where the sprue has to serve the double purpose of sprue and feeder, a larger body of metal is desirable. Under certain conditions a straight sprue raised a few inches higher than usual will insure good castings from pattern and molding equipment that formerly produced nothing but scrap.

Under other conditions the same end may be secured by increasing the diameter, rather than the height of the sprue. The improved design of sprue cutter shown in Fig. 82, was patented and introduced several years ago by a foundryman in the middle West. The principal advantage claimed for this device is that it provides for more than the usual amount of metal in the sprue. This body of metal acts as a feeder and prevents the formation of shrinkage defects in the casting. The design is adaptable and the tool may be made in various lengths and diameters. The diameter will depend on the size and shape of the castings on which it is to be used. The length will depend on the depth of the cope.

In the illustration, 1 designates the thin sheet metal body, open top and bottom and sharpened at the lower edge to facilitate forcing it through the sand. Elongated openings, 2, extending from the top to near the bottom have one side flared slightly outward and sharpened. These sharp edges ream the hole as the tool is forced down and turned through the sand. When the tool is removed the sand core also is lifted, leaving a smooth, tapered hole in which to pour the metal.

The device is provided with a handle, 4, carried at the upper end of the stem, 5. The lower end terminates in a cross piece, 6, riveted to the sides of the body. In practice it is preferable to make the body of two pieces with their edges cooperating to form the side openings and meeting just below the opening as shown. The side pieces are held in assembled relationship by the cross piece of the handle.

A clean passage for the metal is an essential feature on all molds, small and large. The amount of foreign material washed into the casting from a dirty gate will vary in proportion to the size, volume and velocity of the stream and the period of time the stream has been flowing. The comparatively large amount of dross that floats to the top of any mold poured without a cope, indicates that a little more care is required to secure a perfectly clean sprue and gate. Ingot molds, particularly those molded by men during a training period, furnish familiar examples of that feature.

The dross is composed of iron impregnated sand, worn away by erosion and may be due to improper ramming or to unsuitable sand. This point only can be determined by watching closely the process of making several molds over a period of several days. Usually the method of ramming the sand is responsible. It is not rammed to a uniform density. After the mold is dried the soft areas around the sprue will not present as firm a surface as the remainder. As a result the swiftly descending stream of metal will cut away the sand at the weak areas and carry the sand into the mold.

Fortunately, the metal section in an ingot mold is comparatively thick and therefore all the slush usually floats to the top. However, the danger is ever present that some of this foreign material may stick to the side of the mold or the core.

Sticks to the Core

Where the material sticks to the outside of the mold, it does not affect the usefulness of the casting, but it may create an unfavorable impression in the mind of the customer. Where the slush sticks to the core, it may not appear during the cleaning process, but invariably it will make its appearance in the steel mill after one or at most a few heats of steel have been poured in the mold. The inside of the mold wall will yield at the weak point and produce a lump on the face of the steel ingot.

The workman's attention should be directed in a particular manner to the importance of cutting a clean, smooth gate at the bottom of the

Poured at the Bottom

ACCORDING to practically universal custom, ingot mold castings are poured through a long vertical sprue terminating in a gate near the bottom of the mold. Exceptions to this rule include exceptionally large molds where the iron from the first ladle is introduced to the mold through a bottom gate, while the remainder of the metal is poured down into the mold through gates at or near the top. The only hazard incident to the long, vertical sprue is found when the sand is not rammed around it uniformly. In an instance of that kind the rushing metal washes some of the sand into the mold. Danger of boiling action from a wet mold bottom is prevented by forming the bottom face with a thin, rectangular, dry sand core. A close inspection of the metal remaining in the sprue and gate may reveal the origin of otherwise unexplainable dirty areas in a casting.

mold. Preferably a set gate should be employed, that is a piece of wood or metal, the shape of the desired gate, should be placed in position against the ingot mold pattern, and the sand then rammed around it. Application of set gates was covered in a former article in the present series.

Cutting action of the molten metal is greatest at the bottom of the sprue where the direction of the stream is changed from a vertical to a horizontal direction. If the sand is left in a rough, ragged condition, the iron will wash some of it into the mold.

In some instances where the sand is rammed and the sprue and gate formed properly, a certain amount of sand is washed into the mold through a boiling action set up in the metal from contact with sand that has not been dried sufficiently. Steam generated during the pouring process, particularly in the sand surrounding the sprue, will loosen the sand in patches and the flowing stream will carry it into the mold.

Core Causes Trouble

Where the dirty spots are caused by sand alone, that is sand washed up from the interior of the mold, or sand carried in from a dirty runner, sprue or gate, the cavities will be filled entirely with sand, some times free, and sometimes in a partly fused condition. Where the trouble is due to metal boiling from a hard core, a core from which the gas cannot escape inward readily, cavities due to gas bubbles will show in addition to the sand.

A careful examination of the metal remaining in the sprue and gate, frequently has thrown an astonishing light on former dark mysteries relating to sand and other inclusions in castings. If the sprue and gate metal displays warts, bunions and other unshapely excrescences, it is apparent that a certain amount of sand has been displaced. Manifestly the displaced sand did not float upward through the sprue in opposition to the descending metal. Obviously the porous, defective areas in the casting contain sand, or a fused compound which represents the displaced sand after it has been subjected for some time to the action either of boiling, or swiftly flowing molten metal.

In many instances an intensive post mortem is held over a casting without discovering any defective area from which sand has been displaced. The natural assumption is that the sand has dropped, or been washed from the face of the mold or the core. Failing to find any such area the investigators give up the search and class the defect vaguely as from "a cause or causes unknown." A brief examination of the metal that filled the pouring basin, the sprue, or the gate would furnish all the clew required to clear up the mystery.

Before dismissing the subject of ingot molds it may be pertinent to point out that in some instances the sand bottom is made up after the main core is set. This sand is not sufficiently dried when the metal is poured over it and as a result the metal commences to boil and either lifts the sand from the bottom or the agitation liberates graphite or kish. That material may settle against the core and cause a soft or spongy spot that results in the rejection of the casting.

One method of preventing trouble from that source is to place a small, flat, rectangular washer core in the bottom. The core is designed to hug the main core closely and fit loosely in the outside print. In addition to preventing any bubbling in the bottom of the mold, the method also practically eliminates the necessity of machining bottoms of small ingot mold castings.

So far as available records show, a top pouring method for ingot molds is practiced in only one plant. Practically the only advantage of that method is found in the saving of a certain amount of metal. The amount will vary depending on the weight of the ingot mold and will average 150 pounds for molds weighing between 3 and 5 tons.

Special gating and pouring methods usually have to be adopted in the manufacture of exceptionally large molds. What is claimed to be the largest and heaviest ingot mold was made a few years ago in the plant of the Bethlehem Steel Corp., Bethlehem, Pa., for the production of 247-ton steel ingots. The casting as poured weighed 387,590 pounds and the finished weight after cleaning and removing the feeding heads was 382,000 pounds or 191 tons. The casting was 15½ feet high, 108 inches wide across the corrugations at the top of the mold and 97 inches wide across the convex parts of the corrugations.

The mold for the casting was built up in a pit and the metal was poured from three ladles suspended from three cranes and spaced approximately 120 degrees apart around the mold, to which they were connected by long pouring basins. Metal from the first ladle entered the mold near the bottom. Metal from the other two ladles dropped into the mold through a row of pop gates on the top of the mold. The main purpose of pouring the first metal through a gate at the bottom was to form a cushion for the remainder of the iron to fall into. The entire amount was poured in 14 minutes.

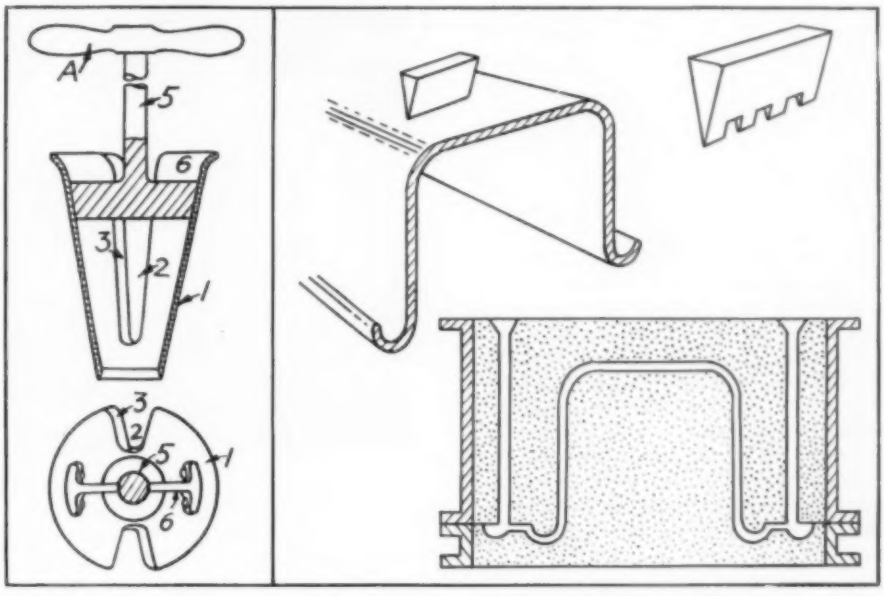


Fig. 82 (Left)—Plan and Sectional View of Improved Type Sprue Cutter. Fig. 83—(Right)—Bath Tubs May Be Gated on Top with Wedge or Finger Gates or at Both Sides at the Bottom as Shown in the Lower Part of the Illustration

In each of the foregoing instances the molds were dried and for that reason the advocates either of top or bottom pouring methods will claim that the method cannot be accepted as a guide or precedent in molds for other castings where conditions may be radically different.

In preceding articles in this series the opinion has been expressed that complete unanimity of opinion on gating methods, never did, does not and probably never will obtain among foundrymen. In stoveplate, hollow ware and sanitary ware shops, metal is poured through various types of gates and the proponents of each type are willing to defend their particular choice against all comers. However, in this connection it is interesting to note that a change of sand incidental to a change from hand to machine molding, frequent-

ly is sufficient to convert the most ardent advocate of one style of gating, to a method which he formerly whole heartedly condemned. In this instance it is apparent that contributory factors and not the type of gate were responsible for the original belief.

Fire pots, bath tubs and other castings of a similar character with high, thin walls may be gated at the top with perfect propriety in some grades of sand. With other sands these castings only can be made successfully if gated at or near the bottom. In the first instance the casting quite safely might be gated at the bottom, but the top gating method is simpler and more economical, therefore it is continued. In the second instance, if the casting is gated at the top the flowing metal will wash away some of the sand in its descent and the result is a rough, scabby casting.

As a broad, general statement, it may be said that a molding machine packs the sand to a greater density than is usual with hand molding and for that reason the sand employed for machine molding purposes is lower in bond and higher in permeability than sand in the hand molding floors. Consequently it is of a tougher, more robust character and better adapted to resist erosing from the flowing stream. Also, its high permeability permits the ready escape of moisture through the proper channels, instead of through the face of the mold with resultant scabs, blisters, cold shuts and bubbles.

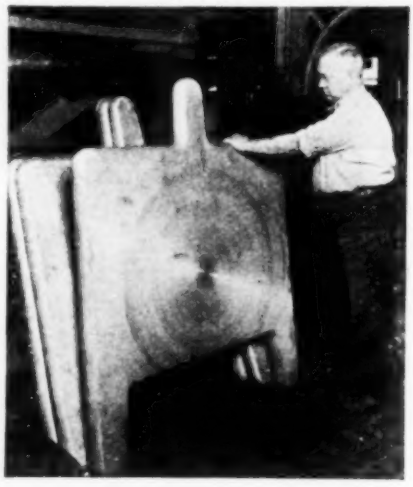
Choice in Gates

Two principal methods for gating bath tub castings are shown in Fig. 83. In the lower illustration the metal is poured from two ladles on opposite sides of the flasks, into two vertical sprues connected at the bottom with long, horizontal runners extending approximately the full length of the casting. Each runner delivers metal to the mold through a number of thin, flat gates. Advantage of the method is that the metal fills the mold cavity as it advances upward without the washing action present when the metal is poured into the mold at the top.

Practically the only disadvantage of this method of gating this particular casting is that the tremendous pressure developed in forcing all the metal upward from the bottom will force the cope and drag sand apart to some extent and create a fin over all the gates and increase the thickness of metal in the lower wall and roll rim of the tub. To prevent this possibility, the sand in the joint area of the flask is rammed harder than the remainder.

In the second method three or four *wedge* gates, *A*, or an adaptation of the wedge gate and known as a *finger* gate, *B*, are placed about 12 inches apart in a straight line on top of the pattern. In some instances a long basin is built on top of the cope to deliver iron from one ladle to all the gates. In other instances an individual ladle is employed to pour iron into each gate. In either instance the metal must be exceedingly hot and must be poured rapidly.

Cast iron pans and troughs for various purposes may be cast as readily without as with a cope. Style of runner and gate will depend to a considerable extent on the general size and shape, but principally on the depth of the casting. A plain basin discharging over the edge into one end will serve satisfactorily for castings up to 12 inches in depth and 6 x 10 feet in area. Above these dimensions it is advisable to place in-gates near the bottom of the mold. On exceptionally large tank castings the bottom gates are supplemented by other gates higher up.



Large Aluminm Castings for New Radio Station Condenser

In special instances where a doubt may exist as to the fluidity of the iron, or where in all probability the sluggish iron rising through the narrow space between the walls, may not cover the bottom of the casting easily and rapidly, the runner basin is so designed that it may be flooded, thus throwing hot iron from the ladle directly over the flat bottom face of the mold.

Where two ladles are employed to pour one of these castings, the iron from one ladle is poured through bottom gates at one end, while iron from the second ladle is held back until the first ladle is nearly emptied. Then the iron from the second ladle is poured directly into the mold from an open, wide mouth basin.

In one typical instance which comes to mind, a pan 4 x 6 feet, 12 inches deep, designed for drying coke breeze for open hearth use, the molding problem was so simplified that an apprentice made a casting in half a day which formerly engaged a first class molder two days. After the coke bed was placed, the boy leveled an open frame pattern on four bricks, one under each corner, rammed the sand simultaneously on the inside and on the outside, vented the inside, scraped away a thickness of sand to form the bottom of the pan, made up the runner at one end, drew the pattern, and the mold was ready. No fancy gates, no rods, no arbor, no cope, no weights, no blocking, in fact practically no feature of any kind to tax either the skill or the time of the operator.

This is the sixteenth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The seventeenth instalment will appear in an early issue.—THE EDITORS.

Condenser Plates Require Aluminum Castings

Condenser plates for use in the radio frequency power amplifier at the new station of KDKA at Saxonburg, Pa., are extraordinary in point of size and precision required. While the corresponding elements in the average broadcast receiver or small transmitting station are made of anything from tin foil to 1/16-inch sheet aluminum, the plates shown in the illustration at the left are heavy aluminum castings. Each plate is made from two castings riveted together to form an element 3 inches thick. Extreme care was exercised to secure castings of this size without flaws since any imperfection would affect the electrical characteristics. The curvature at the edges is not the radius of a circle but is a section designed to give a uniform electrostatic field to increase the arc-over voltage. Surfaces of the plates must be as smooth as it is possible to make them. The installation will include six of the plates shown.

Appoint Representatives

Northern Engineering Works, 210 Chene street, Detroit, has appointed R. E. Condit, 901 East Third street, Dayton and 705 Gwynne building, Cincinnati, its representative in the Dayton, Cincinnati and Columbus, O., districts for its various types of equipment. Hill Equipment Engineering Co., 4620 Delmar boulevard, St. Louis, has been appointed to represent the company in that district.

The second international heating and ventilating exposition will be held in Cleveland, Jan. 25-29, 1932, in conjunction with the annual meeting of the American Society of Heating and Ventilating Engineers and the American Society of Refrigerating Engineers.

Utilize Waste Heat In Hot Blast Cupola

IN THE ordinary cupola process of melting iron, every potential heat unit in the coke entering the cupola is accounted for in one or another of the following six places of disposition: (1) Radiation through the refractory brick lining and metal shell of the cupola, amounting to from 6 to 10 per cent of the heat generated by combustion, (2) Formation of slag, ordinarily about one-third of a pound for each pound of coke burned, each pound of slag consuming about 900 B.t.u. for its formation; (3) Disintegration of limestone and liberation of carbon dioxide, the amount of limestone required for each pound of coke containing about two-fifths of two-thirds of a pound of carbon dioxide, and the liberation of one pound of carbon dioxide from limestone requiring about 840 B.t.u.; (4) Dissociation of moisture in the blast and in the coke, heat consumption for this purpose being negligible in winter months of low humidity, but an important factor on damp days or with wet fuel; (5) Waste gas loss including both the sensible heat and the potential heat (due to unburned combustible) that emerge from charging door and stack; (6) Melting the iron and superheating the molten iron absorbs the heat remaining after the five foregoing deductions, and includes the requirement for raising the temperature of the cold stock to the melting point, for fusion and for raising the temperature of the molten iron to 2600 or 2700 degrees Fahr. or higher.

Other sources of heat arise from oxidation of silicon, manganese, sulphur, etc., but the additional amount of iron melted by that available heat is too small to be appreciable in making fuel economy calculation.

Much Heat Consumed

Items 1 to 4 inclusive, consume from 1600 to 2200 B.t.u. per pound of coke burned, an amount that it is believed cannot be reduced substantially by any practical procedure. Economic improvement in the form of better combustion and fuel saving therefore must come through recovery and utilization from the waste gases (Item 5).

With charges of coke and the raw metal stock deposited alternately in layers, and the lowermost charge of coke burned at a zone of combustion to which the blast air is introduced, the coke in this bed layer burns to a large percentage of carbon dioxide and a relatively small percentage of carbon monoxide. Heat in the gases of combustion passing upward through subsequent layers of coke renders these higher layers incandescent and the percentage of carbon monoxide materially increases.

Since carbon monoxide must exist in the gases of combustion to create a reducing condition and to prevent oxidation of the metal, the most active influence in lowering the quality of the melted iron, combustion of the carbon must be incomplete.

In starting an ordinary cold blast cupola, the percentage of carbon dioxide given off at the combustion zone gradually increases and that of carbon monoxide decreases until a balance is reached at about 10 to 12 per cent of carbon dioxide and 15 to 18 per cent of carbon monoxide. The percentage of carbon monoxide then gradually increases as the gases pass through the upper charges, until at the stack it represents 40 per cent or more of the rising gases. Every additional pound of carbon monoxide that can be burned to carbon dioxide liberates an additional 10200 B.t.u., which represents the heat value of about ¾-pound of coke.

Secure More Uniform Control

For the dual purpose of effecting substantial fuel savings in the cupola, and of securing more uniform control of metallurgical conditions in the production of chilled-iron car wheels, the Griffin Wheel Co., in 1925 experimentally equipped a 20-ton per hour cupola operating at a daily capacity of 150 tons, substantially as is illustrated. The plan was as follows: To withdraw most of the gases from the cupola at a location just below the charging door; To complete the combustion of the extracted gases (converting their carbon monoxide into carbon dioxide); and to transfer most of the resulting sensible heat into blast air and back into the melting zone of the cupola.

Calculation indicated that preheating the blast air, without the use of additional fuel, would raise the temperature in the melting zone of the cupola, improve combustion, speed melting rate, impart a higher temperature to the molten iron, and reduce coke consumption.

The gases drawn off just below the charging door as is illustrated, pass through a row of surrounding ports into a circular gas duct and then are led to a refractory furnace, where, in the presence of sufficient air bled from the blast line, they are ignited and burned completely to increase their temperature to the maximum. From the furnace, the completely burned gases pass into a preheater, therein transfer most of their sensible heat to the blast, and then are discharged through a small supplementary stack. The whole gas system from the hot gas take-off at the cupola to the auxiliary stack, is kept under suction by an induced-draft fan discharging to the atmosphere.

Applicable To Any Cupola

Experience with this experimental installation indicated that any cold blast cupola could be equipped similarly without interfering with operations, without temporarily reducing the output and without any change in practices of charging and pouring. The results of the change-over were so gratifying that the Griffin Wheel Co., gradually but completely converted all the cupolas in its 12 plants to this hot blast system.

Substitution of hot for cold blast has not affected heat losses in cupola radiation, formation of slag, liberation of carbon dioxide from the limestone, and dissociation of moisture from coke and air. Practically the same amount of air is required to combine with the carbon of the fuel regardless of the temperature of the blast. The only thermal effects of the hot blast are to carry more sensible heat into the melting zone, to increase temperature there and throughout the most active portion of the cupola, and to utilize profitably almost all the potential heat in the excess of carbon monoxide over that required to prevent oxidation of the metal.

The gases left in the cupola to pass up through the further successive charges are reduced in volume, travel slower, and on account of the longer period of contact, can give up a greater percentage of their sensible heat than is possible where the large volume of gases is forced through the top of the cupola.

Improved combustion and higher temperatures within the cupola, also waste heat recovery and utilization, as effected by the hot blast, offer

claims for economic improvement in some desirable combination of the following forms:

1. A cupola capacity increase of over 10 per cent through acceleration of the melting rate. Some installations have produced an increase of capacity beyond that of the melting floor to absorb.

2. A fuel saving of not less than 25 per cent, due to the more complete extraction and utilization of the heat from each pound of coke. This saving carries with it a corresponding saving in labor and power in that less coke and consequently less limestone are charged into the cupola, and the number of trips of the charging buggies is reduced.

3. Sensitiveness and uniformity of cupola control is secured due to steady high temperature in the melting zone, and the desirable heat gradient in the gases above. The tuyeres remain open, clean and bright throughout the entire heat, and the smoother combustion and melting conditions have been found to produce an improvement in the chemical and physical properties of melted iron of any grade.

4. Superheat in the molten iron imparts greater fluidity and a free-pouring quality. In the manufacture of thin-walled and intricate parts, such as automobile engine cylinder blocks loss from rejections is said to be reduced greatly.

Wide variation in results at different times in the same cupola and in different cupolas is caused primarily by the irregularity with which the iron, fuel and limestone are placed in the cupola and the rate at which the air is introduced into the combustion zone. Through elimination of the burning gas and excessive heat at the charging door, the hot-blast process enables the operator to see the conditions inside the cupola and without special skill, to place the iron, coke and limestone charges uniformly level.

Extraction of most of the waste gases and their sensible heat before reaching the charging door permits better conditions on the charging floor. The absence of enervating waste heat and fumes, particularly when augmented by natural summer heat makes the operator more alert and enables the management to get and keep better men for this work.

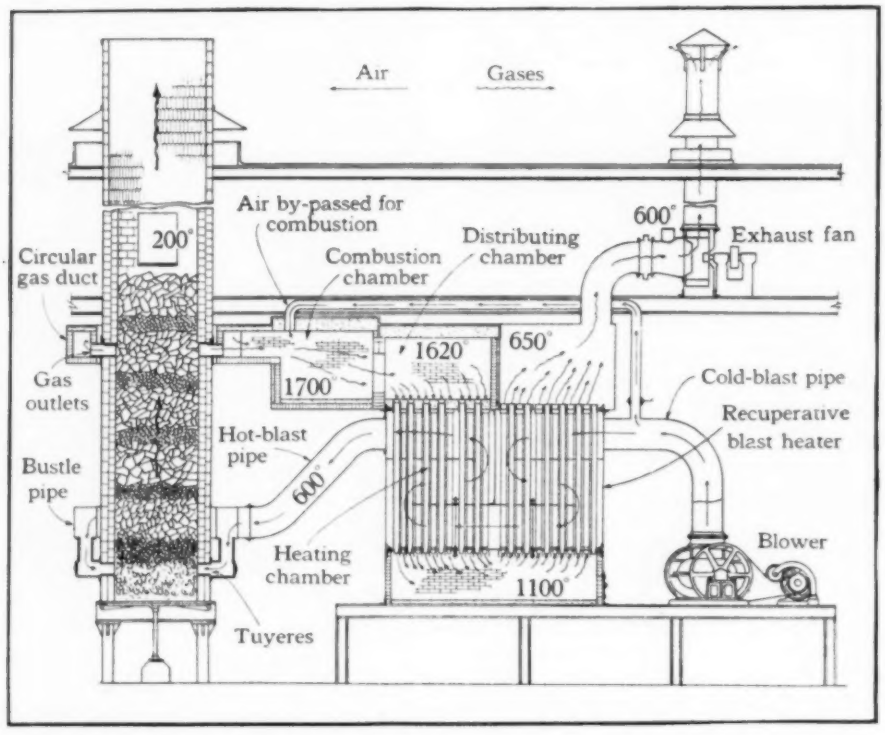
Partly because of the reduced fuel consumption and partly because of the direct heat transmission due to preheating of the air itself, the amount of blast air with this hot blast process is less per ton of iron melted, than is required with a cold blast. The blast pressure is reduced one-third. The total power requirement for cupola blower and gas exhauster is less than for blower alone of a cold blast cupola.

A reduced amount of coke means a reduction in fluxes, and hence less slag produced. That not only is a saving in itself, but is an element in the economy of fuel and assists in increasing the iron temperature.

Sulphur, objectionable in almost all classes of castings, is taken up from the fuel in the melting operation. As 25 per cent less coke is used with the hot blast process, the sulphur pick up should be only three-fourths that which normally occurs with a cold blast.

Recent improvements for higher heat recovery and reduced maintenance include the choice of either a recuperative or a regenerative blast heater, the selection is dependent upon what the installation is to accomplish.

The recuperative blast heater, consists of one or two banks of straight vertical cast iron tubes set between top and bottom sheets, housed within an insulated sheet steel casing containing the air inlet and outlet connections, and provided at the ends with refractory lined inlet and outlet chambers and other connections. Gas travels through and the blast air around the tubes. Staggered baffles in the air space compel the air to pass successively through three or more passes in each tube bank. Inlets and outlets are arranged so that the hottest air travels closest to the hottest gas (counterflow).



Typical Arrangement for Waste Heat Recovery and Utilization in Preheating the Cupola Blast

Alloy Steel Is Used

The inlet tube sheet at the location of the hottest entering gases is high-chrome-nickel steel and the tube ends project several inches above the tube sheet and have intervening space filled in with plastic fire clay to protect the tube joints against the extremely hot gas.

In the regenerative blast heater gas coming from the cupola and refractory lined furnace enters an upper semicircular chamber, flows horizontally through the rotor passages to the opposite side and is drawn to the auxiliary stack by the exhaust fan. Blast air from the cupola blower is forced continuously into the lower chamber on the opposite side, flows horizontally through passages in the rotor (in opposite direction to the gas travel), and is discharged into the front bottom chamber, from which ducts carry it to the wind box and tuyeres.

The small parallel streams of hot gas flowing through the rotor give up heat to the metal heating surface. This porous mass of metal acts as a storage reservoir in which the extracted heat remains until the rotor travel carries the heated metal into the path of the cool blast air in the opposite side of the preheater. At this point, the thin streams of comparatively cold air traveling through the rotor passages in the reverse direction, absorb the heat from the metal mass cools.

The compact arrangement of corrugated metal sheets alternating with flat sheets crowds an enormous amount of intensely effective heating surface into small space, thereby giving the heater small dimension and weight for given capacity. The uniform slow rotor motion at a maximum speed of three revolutions per minute makes the heat transfer process continuous.

Group Apprenticeship Programs Require Close Study

By Harold S. Falk

THE first thing to bear in mind in getting a district apprenticeship plan under way is that the project will require attention and hard work. Business men frequently think that after they have met and decided to establish apprentice training, the work will get under way without anybody doing anything funrther about it. Someone must assume responsibility for the training enterprise and must make it his objective and push it with all possible energy.

Assume that a manufacturer's association is considering apprenticeship. The first step is the presentation of a formal statement by enthusiastic persons, as individual members of the association, before a meeting of the association. This statement should outline the need for apprentice training in the locality and in the industry, and should recommend and urge the association, officially to undertake the development of apprenticeship.

Skilled Mechanics Lacking

In addition to pointing out other factors which the local situation may warrant, the statement should emphasize the lack of skilled mechanics which exists in the community and from which the members of the association undoubtedly have suffered.

The report of these enthusiastic members should explain the relative importance of the local mechanical industry and analyze, if possible, the occupations selected by the graduates of the local schools and high schools to demonstrate that the mechanical industry is not getting its proper share of desirable young men of the community. The statement should bring to the attention of the association the normal loss in skilled mechanics in an industrial community every year. Few employers realize that their force of mechanics constantly is growing older and that the oldest are constantly passing out of the industry and must be replaced. The most conservative estimate of this annual loss is placed at 5 per cent per year.

Members of the local association may not fully appreciate the extent to which educational work has been developed in American industry in recent years, and may be warned that failure to undertake work of this kind may cause the industries of the district to fall far behind their competitors in other localities in those advantages which are the direct and indirect result of educational activity.

It is important for industries in a community that the people who live in the city or district shall be of the highest possible caliber. Therefore, the first report to the association should point out how the industries can play an important part in creating a superior population by providing for the young men of the community adequate opportunity for trade work and training.

The most important part of the report will consist of a plea for united action on the part of the association rather than spasmodic attempts in the organization of training by one or the other individual employer.

An important factor in successful apprentice train is the good will of the community, of the parents, teachers, pastors, social workers, civic organizations and others interested in young men. The undertaking will not succeed without their support.

The report which the interested members make to the association on the subject of apprentice training in an open meeting will undoubtedly be received favorably. It is unlikely that any member who has not studied the question thoroughly can successfully contend against the supporters of the movement who have given the matter considerable thought and attention. The result will be the appointment of a committee to take the necessary action for the institution of apprentice training. The enthusiasts who presented the report probably will be appointed to the committee.

Committee Begins Work

The committee then will begin work. At first they will leave the members of the association severely alone. There is no need to urge them until there is something to urge. The first business of the committee will be to evolve a plan for the district undertaking. The initial step in development of such a plan is a thorough study of the subject of apprentice training. During this first period the committee members will need to work alone, although they may occasionally compare notes. Each member will accumulate the greatest possible amount of information on the subject.

After accumulating a set of notes, each should discard all which do not have a local application. This done, the committee meets once more and each member presents the data which he has gathered. There

Outlines Functions

THE value of replacing through the medium of apprenticeship training the 5 per cent of skilled mechanics that leave industry annually is the subject of this article, which is abstracted from a paper presented at the Chicago convention of the American Foundrymen's association. Apprenticeship training, to be of the most value to a community, should be undertaken by a group or association of local manufacturers. That will avoid the condition of a few industries training the skilled mechanics for the entire community and thus bearing the entire burden of the work. The author outlines a procedure for the establishment of a community apprenticeship program and gives the steps that should be taken by a committee assigned to organize such a program. He warns that many difficulties will be encountered and that the success of the committee in establishing community-wide apprenticeship will be accomplished only if tact, patience and perseverance are used. The author is vice president and works manager, Falk Corp., Milwaukee, and one of the recognized authorities on apprenticeship training in the United States.

will be duplication and many items and suggestions will not be acceptable to all the members. The result of the meeting should be carefully selected information which all members of the committee consider relevant and important. One or two members of the committee, perhaps the chairman and one other, will work this acceptable material into a coherent plan. If all members of the committee try to work at this task, utter confusion will result. It is much better for one or two members to prepare the plan and submit it at a later committee meeting for criticism and adjustment.

Outlines General Plan

The plan should include the following: The central supervisory committee or organization; trades in which apprenticeship is to be established; classifications of apprenticeship in the various trades; work schedules; pay schedules; complete arrangements for school attendance and development of suitable school instruction; the source of candidates for apprenticeship; age limit, if any; form of the contract or indenture; method of certification of graduates of the apprentice courses; method of hiring apprentices and of discharging them when necessary; supervision of apprentice training in the plant; credit to be granted for previous work in the trade; term or length of the apprenticeship courses, preferably in hours; exchange of apprentices between plants in the association; and other important matters.

When the plan has been adjusted and corrected until it is satisfactory to all committee members, it is presented by the committee before a general meeting of the association, where the committee members will explain and defend their plans if necessary and will make notes of corrections and adjustments which the discussion in the general meeting may require. Immediately, if possible, and at a later meeting if corrections are called for, the plan will be accepted by the association and the committee will be directed to proceed with the organization of the work among the members of the association.

The next step of the committee will be to get the work under way in plants of the members, and the first thing to do is to excite the interest and enthusiasm of the individual shop organizations. This can be accomplished most easily by calling a meeting of foremen and department heads to get their advice and suggestions, and by appointing a committee of their number to assist in building up an apprentice training system which will suit their own requirements and, at the same time, comply with the specifications which the association has chosen. Men who have lived all their lives in a manufacturing atmosphere, who are skilled mechanics themselves and who will give apprentices their actual training and engage them after they have graduated, can be depended upon for much extremely valuable advice. During the meeting of foremen and department heads called for this purpose, it will be well to explain the arguments and decisions which have been reached by the apprenticeship group and the association as a whole.

A plan for the training of apprentices in the shop can be worked out easily from the suggestions which the foremen and department heads will make, combined with the recommendations which have been approved by the association. The plan for apprentice training within the plant must include the selection of the trades and courses which are to be provided in the program, schedules for work and pay in compliance with the regulations of the association, an organization which shall be in direct charge of the work, records for the administration of training and definite arrangement for school work in compliance with the local policy whereby related instruction will be given in vocational and public schools, or in private classes.

Harold S. Falk

When plans are completed, it is time to engage one or two apprentices, not more than that number. By starting out with one or two apprentices, personal apprentice problems can be kept at a minimum and most of the time and attention devoted to the development of the system. After the system has been running smoothly and the burden of organization has been reduced, more boys may be taken on and cared for properly.

The first apprentices must be selected carefully, because the entire undertaking depends upon them. If they are successful, the organization will be likely to accept apprenticeship. If they are failures, the movement will be rejected, and it may be years before another trial for apprenticeship can be secured.

When the training of apprentices has been carried on successfully for many months in the shops of the committee members, and has become a regular department in the operation of those shops, committee members will be ready to go out among the other plants in the district and promote the establishment of apprenticeship by a strong argument in the form of a record of achievement.

In organizing apprenticeship in the plants of the members of the association, the apprenticeship committee will encounter its greatest difficulty. The success of the committee will depend upon thorough knowledge of the subject, on tact, on patience and on perseverence. Too much aggressiveness will create antagonism. More will be accomplished by a constant, quiet and relentless effort.

Organization Work Begins

At the beginning of their work, it will be well for the committee to divide the plants of the association among themselves, so that each member may concentrate on the calls which have been assigned to him. The committee may meet at intervals to discuss difficulties and objections which the members encounter in various shops, and work up answering arguments. Under certain conditions it may be good for several members of the committee to go together to meet some manufacturer who might be influenced by a delegation more easily than by an individual, or whose objections and attitude may require the attention of more than one member of the committee.

The committee should take the greatest possible advantage of the adoption of apprenticeship in such plants as have gone ahead with the movement, because most people are impressed by the fact that any considerable number of people whom they respect are doing a certain thing. As time passes, some employers may establish apprenticeship in their plants for no other reason than that they do not wish to be considered backward or out of line with a prevailing movement.

After a member of the association has agreed to install apprentice training, the committee can assist him in getting the work under way by suggesting a procedure similar to that which has been successful in their own plants. They will give him all necessary information and advice, and help in the selection of a suitable director or supervisor of apprenticeship, and help him in se-

(*Concluded on Page* 79)

BILL

By Pat Dwyer

Explains Why Ingot Molds Are Rough

IN THE opening chapter of one of his justly famed hilarious romances, P. G. Wodehouse comments on a peculiar feature that by no means is confined to the stately homes of England. I have not the book by me at the moment and it is possible that my memory for the words is not infallible in every detail, but in a general way the following may be accepted as a fair—if somewhat condensed—translation of a statement which the ever exuberant and prolific Mr. Wodehouse succeeded in spreading over the greater part of the first page:

The clock over the stable had just struck nine mellow notes. The hall clock had struck the half hour. The cute little Dresden china clock on the mantelpiece showed seven minutes of eleven. My Lady's platinum wrist watch still ticked bravely and the hands indicated 10:15, while the small traveling clock in a plush case on a table beside the bed held up both hands coyly to declare that the hour and minute was 8:17. Indicators on a ship's clock hanging on the wall showed the time of high and low water, the relative position and condition of the moon and planets and other interesting features. The hands pointed south, and southwest-by-west, which means that the long hand was directly perpendicular with the point at the lowest mark on the clock circle and the point of the short hand rested between the VIII and the IX. A landlubber would say that the clock gave silent evidence of the time, 8:30; while a yo-ho-ho and a bottle-of-rum-boy fortified by hearing a single stroke on the gong, would come out barefoot and flat-footed as becomes a sailor and tell you the time "Just gone one bell."

By all these various signs, omens, portents, or what have you, the dowager knew it was exactly seven minutes of 9 a. m. and forthwith rang for the morning spot of tea.

According to all appearance, respect for accuracy in the spoken, written or picture form, rapidly is passing out of existence. The most outrageous statements are made, statements that should challenge the credulity of a child not over ten, and yet these same statements are accepted by the public without protest, suspicion or examination. A recent picture, highly praised by all the critics, shows a flock of kangaroos, despite the fact that the scene is supposed to be laid in Africa.

After the recent set-to between Mr. Schmeling and Mr. Stribling for the pugilistic championship of the world all the newspapers carried stories dealing with the financial features of the entertainment I've heard worse names.

Anyway It Was Near the End of the Week

When describing a bona fide, genuine enterprise, a new business venture, something that has nothing to hide and everything to gain by publicity, the newspaper writer cautiously inserts *it is said, it is alleged, according to a statement*, and other pussy footing, saving clauses to show that he does not necessarily indorse any of these items of news. Just merely passes them along for what they may be worth. The reader is warned that he can believe them or not just as he chooses.

When describing a prize fight, a form of sport admittedly as straight and on the level as a package of angle worms, the writers discard all the little safety first devices, the equivocal introductory phrases including the favorite: *According to the police*. They come out boldly—perhaps brazenly would be the better word—and reveal all the intimate financial details of the venture. These writing lads place such childlike and intimate faith in the statements of the publicity agents, that they do not even add the proverbial 2 and 2 together to determine if the result is 4. The picture the reader gets of the promoters is that of a bunch of big good natured boys, talking without the least reserve of their financial affairs. Interested solely in clean sport for its own sake, and perfectly willing to throw away immense quantities of real money to make a Roman holiday for all those who care to participate.

"What's a few hundred Grand more or less?" these boys declare boldly on the front page. "It'll probably set us back three or four hundred Grand to put on this bout, but we have sufficient faith in a public which likes clean sport, which knows what it wants and is willing to pay for it. Yes, sir, we have sufficient faith in this thing to justify us in the hope that we at least shall break even. If we make a little, all well and good. If we lose a little, well, it's the fortune of war. What was it Sherman said, eh? Har, Har. Well, we'll be seein' ya!"

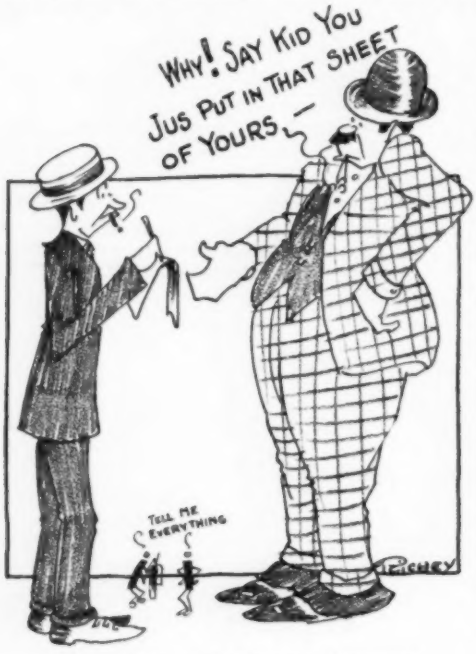
On the day following the fight we—the public—learned with deep regret that the promoters had been nipped cruelly. They faced a loss of approximately $300,000, or, in their own language, three hundred Grand. Other figures were given elsewhere in the story covering the attendance, the total gate receipts, the fat share claimed by the winner and the comparatively small share given the loser—manifestly an injustice, since one gladiator was as necessary as the other to the success of the battle. Also, no account seems to have been taken of the important fact the loser was pounded to a pulp.

Ordinarily the figures would have left no impression, or at best but a hazy impression on my mind, but an antagonistic instinct, goaded beyond all bounds, by the constant ballyhoo, prompted me to check some of the given figures against others. Apparently, the diligent young lad responsible for the figures in the paper had neglected this little item. Perhaps in deference to the gladiatorial nature of the contest, he used the Roman system, with its many pitfalls of misplaced Xs, Ms, Ds and Ls waiting for the unwary. Whatever his system, the result failed by a wide margin to tally with mine, secured through the ordinary or Arabic method of notation.

The writer admitted that while the figures might not be accurate down to the last mill, the one-tenth part of a cent, they were approximately accurate. Also the figures were in round numbers, presumably to keep them in harmony with the remainder of the story, told round by round.

So far as their roundness went, I

had no objection to offer, but when the approximation showed a discrepancy of nearly $200,000—beg pardon—two hundred Grand, between the total and the various items from which the total was set up, I really felt that the writer had stretched the meaning of the word *approximately* beyond all reasonable or decent bounds. Two hundred thousand dollars might seem like a trifle to him,



The Reporter Insists on Accuracy

but down in our part of the country people still regard that amount with respectful admiration, in some cases even with awe.

Kindly correct me if I have gone astray in my calculation. If you find that I am right, please indicate same on space reserved for that purpose on the enclosed, self-addressed, but not stamped, envelope. I shall measure the extent and heartiness of your approval by your willingness to go down to the corner drug store to buy a stamp for the envelope. On your marks! Get set! Go!

Total receipts were given as $400,000. Out of this the promoters had to pay $300,000 for preliminary and promotion expense. The winner of the fight received 40 per cent of the gate or $160,000. The loser had to be content with 12 per cent, a mere $48,000. I wonder how many foundrymen cleared $48,000 on July 3? What, no hands up?

However, perhaps it is just as well. If you have no money of your own to worry about, you can devote all your attention to solving this problem, or to explaining this apparent phenomenon: Total receipts $400,000, total expense $508,000, total loss $300,000!

Shortly after reading this thrilling mystery story I asked Bill if he could present any explanation, that is to say, any reasonable or satisfactory explanation. Over a long period of years I have learned that explanations do not always explain I warned Bill he should be careful and watch his step.

"Well," said Bill, "I'll tell you. If I knew how these pugs and all connected with 'em worked this here now fighting racket and made a fat living out of it, do you suppose I'd be toiling and moiling like old what's-his-name, the blacksmith, day in, day out, for what in sporting circles would be regarded as a mere pittance, small change to be handed out in tips to various classes of menials who thrive on that form of remuneration.

"The old fighting game ain't what she used to be when men fought for fun, for spite, for the honor of the race, for a barrel of beer, for two dollars, for no particular reason that any person could recollect after the two contestants were borne bleeding and unconscious from the field of honor.

"Backers and followers lined up in two violently hostile camps and were as ready as their respective champions to fight at a word, at a wink, at a lifted eyebrow, or a fancied derogatory shrug of the shoulder. Blind faith led them to bet heavily and implicitly on their idols even when ordinary common sense should have warned them that they were placing their faith on broken reeds.

One of the stories that survives the colorful Sullivan-Corbett era illustrates this point and also illustrates how misunderstandings arise through people talking at cross purposes. Each one wrapped up in his own affairs and seeing things through his own particular pair of spectacles, eye-glasses, winkers or blinders. By the way, I wonder how all these names came into existence. Eye-glasses seems obvious enough, but spectacles—I can't quite figure that one out. Have you any ideas on the subject?"

"Anything out of the ordinary is a spectacle," I reminded him. "For example, a man who starts to tell a story and then rambles off into a speculation on the probable origin of the term spectacles, quite properly comes under the classification. Since professional fighters usually do not wear glasses or spectacles—at least while engaged in their professional duties—I see no reason for introducing the subject. Objection over-ruled and evidence is ordered stricken from the record. My learned friend kindly may proceed, but he is warned to confine himself to the points at issue."

"That's one way of bluffing your way out of a situation," Bill remarked cheerfully, apparently in no whit (what is a whit, anyway?) abashed. "When you don't know the answer you throw up a smoke screen and escape, or you squirt the old ink sac in the water like one of these what-do-ya-call-'ems, octoroons or octopussies. Say, that reminds me—I don't suppose you know the answer, but I'll try you out anyway: Does the term octopus mean eight cats combined in one, a kind of a ring-tailed roarer, a holy terror magnified 8 diameters, or is it one of these quaint sea terms referring to a fancied resemblance to a pussy with eight legs? You don't know the answer? I thought not. Let us hasten on to the next order of business.

"Two men sat side by side in a street car the day before the famous passage at arms between John L. Sullivan and James J. Corbett, Sept. 7, 1892, in New Ordeans. One of the sitters was a merchant. Greatly perturbed he was over the general stagnant condition of busines as reflected in the columns of the paper he was reading. One of the periodical panics that sweep over this country was sweeping pretty industriously at the time and this business man was feeling anything but optimistic.

"He turned to his neighbor, an honest artisan in overalls with a dinner pail under his arm and the stem of a short clay pipe peeping out of his upper vest pocket. This sturdy citizen eagerly was lapping up all the news of his hero from the sport page. Filled with visions of blue ruin and bankruptcy, hard times, empty warehouses and idle factories, the merchant said to the man at his side, 'I wonder how it's all going to come out?'

"The other lad favored him with a look in which pity and scorn were nicely blended. 'Come out?' He wrinkled his nose, pulled back his upper lip and protruded his lower lip disdainfully, 'I'll tell oo how it's goin' to come out. Soolivan is goin' to bring Caurbit home to Boston in a bag. That's how it's goin' to come out!'

The Fan Like a Roaring Lion Seeketh Information

"I had a letter the other day from a man who was having trouble with the inside of his ingot mold castings. He claimed the metal washed the blacking from the core and as a result, the interior of the casting was so rough that it was unacceptable to the customer. Roughness on the outside of an ingot mold is not a factor of major importance, but the inside must be smooth and flawless.

"The casting is 5 feet high, 9 x 26 inches on the inside, from 3¾ to 4¾ inches thickness of metal in the walls and weighs approximately 5000 pounds. The metal enters the mold through a gate at the bottom, which is common practice in practically all foundries where these castings are made. Instead of giving me some of the characteristics of the sand and the method employed in making the cores, he contented himself with telling me that the core mixture is made up of 4 barrows old sand, 13 barrows new sand, 11 barrows sharp sand, 4 pails core compound. The entire mixture is wet down with thick claywash.

"Unfortunately the information furnished in this letter is of practically no value so far as assisting me to arrive at a decision on the cause of the trouble. A tabulation of the actual amount of each kind of sand is of no value without a knowledge of the characteristics of these sands. I have no means of knowing whether the sand is fine or coarse, close or open, high or low in bond, highly refractory, medium or low. Holding capacity of wheelbarrows vary to a considerable extent. Even the same barrow will vary in holding capacity in the hands of different men. Therefore, the statement that 4 pails of core compound were added to 28 barrows of sand is not definite enough. Pails also vary in size.

"Perhaps the most important of all he did not state whether the core is made horizontally as a solid block in a corebox, or built up vertically from 1 to 1½ inches thick around a cast iron core barrel. From the volume of sand mentioned, I am inclined to the supposition that the core is made up as a solid block, but of course I may be mistaken in the event that he is making a considerable number of castings per day, and merely gives the makeup of one batch of core sand. Irrespective of all the foregoing features, I can see no reason or excuse for wetting down this apparently well bonded material with thick claywash.

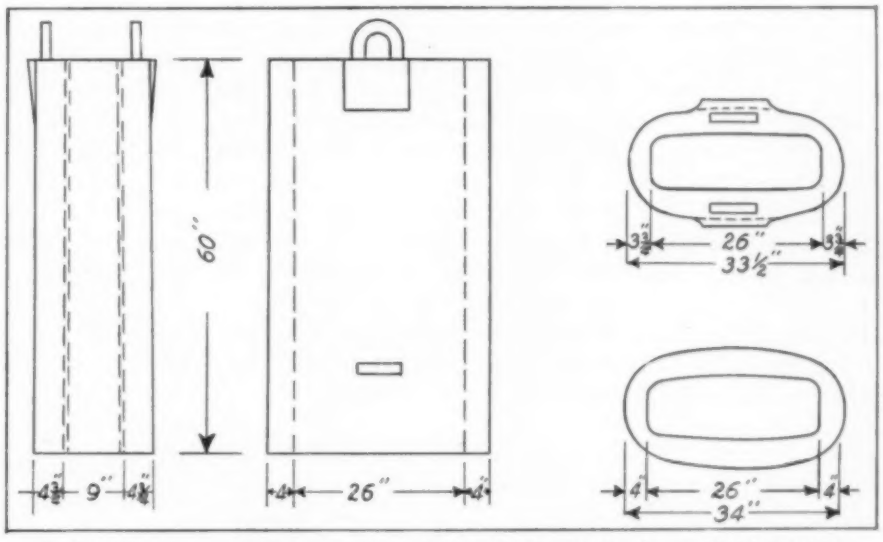
"Core sand mixtures for ingot mold castings vary almost as widely as the sizes and shapes of the castings. In the East and South a highly refractory, coarse, naturally bonded sand is employed to form both the outside and the inside of these castings. The sand is used in its natural state, with the single exception that the proportion of new and old sand varies to some extent for the core and for the outside.

"With one notable exception, all the ingot mold makers in this country—and this probably holds with ingot makers in foreign countries—ram the core in an upright position around a cast iron barrel, black and dry it in that position and finally set it up in that position in the assembled mold. This feature accounts to some extent for the use of molding sand in the core. Sharp sand is the most refractory, but manifestly sharp sand alone could not be formed into a vertical core from 5 to 7 feet in height. In the foundry referred to a moment since as an exception, the ingot mold cores are made from sharp sand bonded with oil. The core is made and dried in halves in a horizontal position, then the exposed ends of the cast iron arbors are bound together with wire and the assembled core is laid in the horizontal half mold. The cope half of the mold is lowered into position and the entire assembly is up-ended and made ready for the metal.

"Without a knowledge of the available sand in any foundry, it is impossible to suggest a definite mixture. However, the following points must be kept in mind in making a selection: The sand must be highly refractory. That means a low clay content. It must be highly permeable and that usually means a rough, coarse texture. It must be thoroughly dried. Provision must be made for the rapid and easy escape of the gas. Any sand that conforms to these requirements will serve the purpose satisfactorily.

"In some instances where a half and half new and old fairly coarse molding sand has been rammed around a core barrel, relief from scabs and blisters has been insured by adding a shovel full of sawdust to each barrow of sand. In other instances the scabs and blisters have been traced to plugged holes, or lack of vent holes in the core barrels. When the plugged holes were opened, or where holes were drilled in the unvented areas, the scabs and blisters disappeared without any change in the sand.

Assuming again that the core in this particular instance is formed horizontally in a core box and assuming that the molding sand is of a fairly satisfactory character, I suggested that the core sand mixture be made up principally from sharp sand, with just sufficient molding sand to give the core a body and prevent it from sagging during the drying process. The relative amount can be determined only by experiment. A minimum amount of core binder is sufficient. This point also may be determined in advance by mixing a small trial batch of sand from which a core can be made and dried. A practical man readily can determine by the feel and appearance of the sample whether the sand mixture is satisfactory or not. It may not be amiss to point out that a good grade of blacking, applied thick, is required on these cores. Also, it is not necessary to pour the metal at a high temperature. With other conditions equal, cold metal will produce a smoother skin than metal poured at an exceedingly high temperature. If he has access to back files of THE FOUNDRY, interesting ingot mold information is presented in the issues of Nov. 15, 1927, and Sept. 15, 1929.



End, Side, Top and Bottom Views Respectively of the Ingot Mold Casting

Pamphlet Is Issued

Smooth-On Mfg. Co., 570-74 Communipaw avenue, Jersey City, N. J., has issued a pamphlet which gives information on the various uses of its product. Information covers its use in making various types of joints; stopping leakage in riveted seams, pipes, containers, castings, cylinders, etc. Two types are used for waterproofing and for floors. Illustrations show how the material may be applied in each instance.

Wilcox, Crittenden & Co., Middletown, Conn., has acquired the National Marine Lamp Co., Forestville, Conn., and has removed all machinery, stock, office equipment and personnel to Middletown.

DAN M. AVEY
Editor

The Shakeout

FRANK G. STEINEBACH
Managing Editor

PAT DWYER
Engineering Editor

EDWIN BREMER
Metallurgical Editor

CHARLES VICKERS
Nonferrous Editor

NORMAN F. HINDLE
Assistant Editor

¶ What, More Variables?

THE tonnage of alloy scrap handled by a Cleveland dealer in alloy and metal scrap during the first five months of the present year showed an increase of 50 per cent over a similar period in 1930 and more than double the same time in 1929, according to a recent article in *Daily Metal Trade*. That is interesting in view of the decline in activity in the iron, steel and metal scrap markets. It shows that the use of alloys is on the increase. Steel foundries engaged in the production of alloy steel castings doubtless are buying substantial tonnages of that type scrap to take advantage of the possible savings in alloy additions. However, what may prove an advantage to one class of foundries may prove a detriment to others for the manufacturer of plain carbon steel castings now must be continually on guard against contamination of his scrap by alloys.

FOUNDRIES, generally, must take a large number of variables into consideration to produce castings successfully. The introduction of alloys has added another to the long list. Foundries producing alloy steel castings must segregate the various types of gates, risers and other scrap according to the alloys they contain. That means higher handling costs, more storage space, higher metal costs and the consequent higher cost of product for which they should receive a higher price, but often do not. In addition, they must be on guard against the introduction of unwanted alloys which will have a deleterious effect on the castings produced. Foundries making plain carbon steel castings must exclude alloys if a uniform product is desired.

A WORD of warning should be issued to foundries purchasing alloy steel scrap. They should be sure that they are paying less for the alloys introduced in the scrap than would be the case if the total addition was made to a heat containing no alloys. The cost of the alloy steel scrap purchased should be less than the price of a similar amount of plain carbon steel scrap plus the cost of alloy available in the alloy scrap taking into consideration the melting loss in the furnace. Foundry cost systems should take that fact into consideration or foundrymen will find that they are operating at a higher cost than is necessary and consequently are reducing the amount of profit to which they are justly entitled.

¶ Too Much Specialization

THE old argument regarding the relative value of campus activities and high scholastic attainment, so familiar to many college graduates, bobbed up again recently all fitted out in a new dress. At a conference on chemical engineering education at the University of Michigan, one speaker declared that new "objective standards" for measuring the graduate are necessary before the training provided by technical schools can meet present requirements of industry. The speaker believes that intellectual accomplishment is the only objective standard by which the graduate now may be measured and that similar standards should be developed by which aptitude and personality may be measured. Such standards would result in fewer men in colleges, but all graduates would be placed in industrial firms simply upon recommendation of college authorities.

A STATEMENT of this kind hints that industry has become a little soft. When it is necessary for the technical colleges and universities to turn out only men of superior intelligence trained in all the fine points of the particular industry in which the colleges believe they will be best fitted, the value of the engineer naturally is narrowed, and his chances for success in the particular field have not been improved. Year by year, demands for specialized courses increase, and universities naturally are listening to those industries of major importance, especially if they may be listed among the heavy tax payers of the state. Thus, smaller industries suffer, the graduate is not given the broad outlook so essential to success in the engineering profession, the cost of operating the university is increased, and due to the many ramifications of the course of study, the university often does not have available funds to secure the best talent for the instructional corps.

RATHER than demand something new, something that will either add to the burden of the university or limit the value of college education to a relatively few, it might be better for industry to accept the technical school as it is today, explain its needs in detail and then cooperate in making the present organization more effective. That is the plan now being followed by the foundry industry through the A. F. A. and other societies of the foundry field.

Personal

E. M. Anderson has been appointed purchasing agent, Massey-Harris Co., Racine, Wis. He formerly was connected with the Massey-Harris plant at Batavia, N. Y.

Gomer L. Shank, manager, Chicago Hardware Foundry Co., Elkhart, Ind., has resigned and has purchased a part interest in a foundry at Akron, Ind. **K. R. Troyer** has been appointed office manager of the Elkhart plant. **R. Selbig** will continue as plant superintendent.

William J. Gibney, formerly vice president, Bingham & Taylor, Buffalo, has severed his connection with that firm and become affiliated with the Strong Steel Foundry Co., Buffalo, as assistant to the president.

L. E. Nutt recently was re-elected president, Moline Iron Works, Moline, Ill., at a meeting of the board of directors. Other officers include **B. V. Nutt,** vice president; **M. C. Nutt,** vice president and secretary; and **John T. Miles,** treasurer. Directors elected in addition to the previously mentioned officers are **William Butterworth, Sol Hirsch, C. R. Rosborough** and **James F. Walsh.**

Group Apprenticeship

(*Concluded from Page* 74)

curing desirable candidates for apprentice training.

After apprentice training has been established fairly well in the industries of the community, the committee should undertake some kind of survey to determine the actual needs of the industry for trained mechanics. The number of apprentices who must be employed in the community may be calculated approximately from the proportion of apprentices who actually complete their courses, based upon known experience. Considerable judgment will have to be applied by the committee in determining these various factors according to local requirements.

The work of installing apprentice training in plants will continue for many years, both because this or that manufacturer may decline to take part in the movement at the start and may not surrender for a long time, and also because new industries will be built up in the community and must be induced to take their proper place in the program.

The members of the apprenticeship committee will maintain interest in the community by the publication of information regarding apprenticeship affairs in the newspapers and by talks before civic organizations, luncheon clubs, boys' clubs, parent-teacher associations and similar groups. They also will make it a point to supply information regarding apprentice training to public and private employment agencies maintained by legitimate organizations and societies. Furthermore, the committee will need to study official and standard work and pay schedules at regular intervals, to adjust them to the change of the times and keep them up to date. A review of wage and pay schedules should be made at least every 2 years, although changes may be required much less frequently.

New Liner Is Propelled by Castings

The largest single bronze castings ever founded, according to reports, are the two inboard propeller screws of the Canadian Pacific Line's 42,500 ton ocean grayhound, the new EMPRESS OF BRITAIN. Each propeller weighs approximately 25 tons, and is 19 feet 3 inches in diameter. The two outboard propeller screws seem small in comparison, weighing 17½ tons each and measuring 14 feet across. The inboard propellers flank the rudder in the accompanying illustration.

Stern View of the Canadian Pacific's New Ocean Grayhound, the EMPRESS OF BRITAIN, *Showing the Large Cast Bronze Propellers*

The four bronze propeller screws had a sailor's holiday when they were transported from the foundry to the builder's yard. They were too large and heavy for shipment by rail and had to be loaded on a coastwise freight steamer. The bronze propeller castings now are driving the largest liner built on the Clyde since the war, at a speed of 30 miles an hour between Southampton and Quebec, cutting through the water at 150 to 200 revolutions per minute, driven by turbines rotating at 1365 to 1795 revolutions per minute.

Metal will meet some exacting tests in various departments of the EMPRESS OF BRITAIN. The high-pressure turbines must withstand a maximum working pressure of 425 pounds per square inch and an initial steam temperature of 725 degrees Fahr., and develop service and overload powers when employing steam between the limits of 375 pounds per square inch gage pressure and 0.50 pound per square inch, absolute pressure, with an initial steam temperature of 700 degrees Fahr. The turbine casings are of cast steel, with the exception of the low-pressure casings which are of gray iron. The gearwheels and pinions are enclosed in gray iron gear cases.

When developing the normal service power of 60,000 shaft horsepower, the reduction ration between turbines and propellers will be about 9 to 1. The rudder was given an emergency workout during the trial runs which placed a terrific strain on turbines and propellers. Going at full steam ahead, the helm was suddenly put hard aport while stopwatches timed the reaction. The ship answered in reassuring fashion. Then with equal suddenness the engine-room telegraph went from full speed ahead to full speed astern. It is an maneuver never likely to be duplicated during the sea life of the EMPRESS OF BRITAIN. Castings in the ship withstood the severe test in an extremely gratifying fashion. The EMPRESS OF BRITAIN made her maiden voyage from Southampton to Quebec on May 27 to June 2.

Increases Facilities

W. B. Coleman & Co., metallurgist, engineer and chemist, has moved its office and laboratories from the Mulford building, Fifteenth and Wallace streets, Philadelphia, to 1920 West Indiana avenue. The company has facilities for chemical and metallographic analysis, physical testing, etc.

OBITUARY

J. A. Merrick, owner of a brass and aluminum foundry at 1149 Grand avenue, Galesburg, Ill., died recently.

Harry R. Armstrong, 72, president of the National Iron Co., Duluth, was drowned at Laguna Beach, Calif.

Edward W. Kerr, for 30 years one of the principal department managers of Pratt & Letchworth Inc., Buffalo, until his retirement 2 years ago, died at Buffalo, Aug. 8. He was 65.

Otto J. Lof, for 37 years an employe of the Norton Co., Worcester, Mass., and lately a representative in Europe, died Aug. 7 in Stockholm, Sweden.

Phillip Tell Dodge, former president, Mergenthaler Linotype Co., Brooklyn, N. Y., died at his home in Rye, N. Y., on Aug. 9. Mr. Dodge was 80 years of age.

Harry M. Ream, 54, treasurer, Steel Shot & Grit Co., Amesbury, Mass., Globe Steel Abrasive Co., Mansfield, O., American Steel Abrasives Co., Galion, O., and Kahn Pangborn Co., Pittsburgh, died recently at his home in Pittsburgh. He also was sales manager, Pittsburgh Crushed Steel Co., Pittsburgh.

Carleton M. Bower, vice president, Southern Wheel Co., New York, died Aug. 10 at the Presbyterian hospital, New York, after an illness of several months. Mr. Bower was born 51 years ago at Clarkston, Mich., and formerly was vice president of the National Car Wheel Co., which later was absorbed by the Southern Wheel Co.

Absorbs Company

Worthington Pump & Machinery Corp., Harrison, N. J., recently acquired the manufacturing and marketing facilities of the Metalweld Inc., Philadelphia. The latter company manufactures a line of portable compressors. The Metalweld line now will be manufactured at the Harrison, N. J., works of the Worthington company and the engineering, manufacturing and personnel of the former organization will be located at Harrison. S. John Oechsle and J. N. Childs will manage Metalweld Inc.

Instruments Are Listed

C. J. Tagliabue Mfg. Co., Park and Nostrand avenues, Brooklyn, N. Y., recently issued a catalog describing its line of temperature recording instruments. The first section is devoted to automatic controllers. The second section describes temperature and pressure recorders of various types and explains methods of testing and operation. The next section is devoted to industrial thermometers and the final section deals with oil testing instruments, hydrometers, distillation apparatus, vacuum gages, moisture meters and automatic gas analysis recorders.

DIRECTORY OF FOUNDRY ASSOCIATIONS

American Foundrymen's Association

President, E. H. Ballard, General Electric Co., West Lynn, Mass.; executive secretary-treasurer, C. E. Hoyt, 222 West Adams street, Chicago; technical secretary, R. E. Kennedy, 222 West Adams street, Chicago.

Associated Brass Founders of New England

President, George W. Thornburg, Crescent Park Brass Foundry, Waltham, Mass.; secretary, Herbert H. Klein, Pennsylvania Foundry Supply Co., 310 Congress street, Boston. Meetings the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. McArthur, Washington Iron Works; secretary, W. J. Wark, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. Hire, Hire Foundry Co., Peoria, Ill.; secretary, Franklin Whitehead, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, L. E. Gilmore, Crane Co., Chicago; secretary, Albert N. Wallin, S. Obermayer Co., 2563 West Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, Carl S. Neumann, Union Mfg. Co., New Britain, Conn.; secretary, Charles S. Parker, Charles Parker Co., Meriden, Conn. Meetings are on second Friday of each month in various parts of the state.

Connecticut Nonferrous Foundrymen's Association

President, C. H. Blanchard, Reading Steel Casting Co., Pratt & Cady division, Hartford, Conn.; secretary, C. D. Elliott, Wilcox, Crittenden Co. Inc., Middletown, Conn. Meetings held the second Monday of each month at place to be named. Recent meetings have been held at Hotel Garde, New Haven, Conn.

Detroit Foundrymen's Association

President, James L. Mahon, American Car & Foundry Co.; secretary, Neil I. McArthur, Great Lakes Foundry Sand Co., 2100 Penobscott building, Detroit. Meetings third Thursday in each month, except December, June, July and August at Ft. Shelby Hotel.

East Bay Foundrymen's Association

Secretary, O. R. Moller, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Electric Steel Founders' Research Group

Director, R. A. Bull, Central Office, 541 Diversey Parkway, Chicago.

Gray Iron Institute

President, B. H. Johnson, Florence Pipe Foundry & Machine Co., Florence, N. J.; manager, Arthur J. Tuscany, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, R. R. Fauntleroy, Moline Malleable Iron Co., St. Charles, Ill.; secretary, Robert E. Belt, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, William Ember, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, William E. Paulson, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue, New York.

New Jersey Foundrymen's Association

President, W. H. Mantz Atlas Foundry Co., Irvington, N. J.; secretary, G. W. Hannay, Barnett Foundry & Machine Co., Irvington, N. J. Meeting called by president. Scheduled meeting dates: Oct. 28, Dec. 2, Jan. 27, 1932, March 23, 1932, May 25, 1932.

New England Foundrymen's Association

President, Luther J. Anthony, Glenwood Range Co., Taunton, Mass.; secretary, Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass. Meetings held the second Wednesday of each month excepting July and August at the Engineers club, 2 Commonwealth avenue, Boston. Outings usually are held in the months mentioned.

Ohio Foundries Association Inc.

President, A. H. Kramer, Advance Foundry Co., Dayton, O.; secretary, Robert Hoierman, 418 Penton building, Cleveland.

Pacific Coast Founders Association

President, Charles J. P. Hoehn, Enterprise Foundry Co., 2902 Nineteenth street, San Francisco; manager, S. M. Truitt, 55 New Montgomery street, San Francisco.

Philadelphia Foundrymen's Association

President, J. B. Greenstreet, Olney Foundry Co., Philadelphia; secretary, Earl Sparks, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Pittsburgh Foundrymen's Association

President, H. F. Siefert, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; secretary-treasurer, William J. Brant, Wm. J. Brant, Bessemer building, Pittsburgh. Meetings on the third Monday of the month, except in July and August at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, E. A. Gullberg, Union Malleable Iron Works, East Moline, Ill.; secretary-treasurer, Stanley Brah. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

St. Louis District Foundrymen's Club

President, W. C. Raithel, Century Electric Co., St. Louis; secretary-treasurer, Leo J. Filstead, John C. Kupferle Foundry Co., St. Louis. Meetings the fourth Thursday of the month at 6:30 p. m., at the American Annex hotel, Sixth and Market streets, St. Louis.

Southern Metal Trades Association

President, John S. Schofield, J. S. Schofield's Sons Co., Macon, Ga.; secretary, W. E. Dunn Jr., Flatiron building, Atlanta, Ga.

Steel Castings Development Bureau

Research Director, George Batty, 500 Stock Exchange building, Philadelphia.

Steel Founders' Society of America

President, W. H. Worrilow, Lebanon Steel Foundry, Lebanon, Pa.; managing director, G. P. Rogers, Graybar building, New York.

Tri-City Technical Council

Chairman, C. F. Scherer, Davenport Machine & Foundry Co., Davenport, Iowa; secretary, E. C. Xander, assistant secretary, Tri-City Manufacturers association, Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, William Hoppenjans, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, C. C. Erhart, Chris Erhart Foundry Co., Cincinnati. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, Frederick Christensen, R. R. Howell & Co., Minneapolis; secretary-treasurer, C. E. Langdon, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club

President, Rex L. Alexander, Olympic Steel Works, Seattle; secretary, Edward C. Gustin, 3716 Grayson street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Western Foundrymen's Association

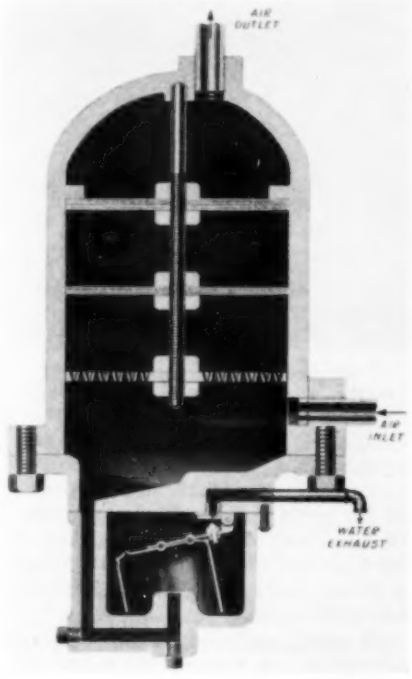
President, H. T. Hornsby, Joplin, Mo.; secretary, E. L. Graham, Acme Foundry & Machine Co., Coffeyville, Kans.

Wisconsin Gray Iron Foundry Group

Secretary, W. F. Bornfleth, Cutler-Hammer Inc., Foundry Division, Milwaukee. Meetings on second Wednesday of each month at Hotel Schroeder, Milwaukee.

Unit Separates Oil and Water from Air

Jas. A. Murphy & Co., Hamilton, O., has introduced a new type automatic separator which extracts water and oil from compressed air. The accompanying illustration shows the method of operation. Air enters the separator at the bottom at a tangent giving the air a swirling motion which is claimed to precipitate 75 per cent of the moisture. The air



Air Is Filtered Through Bronze Screens

then ascends in the unit through fine holes in the first baffle plate and through each succeeding chamber and baffle. In passing from one chamber to another the air passed through finely graduated bronze screens which withdraw the remaining moisture from the air. The water descends to the built-in, automatic trap.

The housing of the separator is a high-grade gray iron casting and all baffles and inner parts except the valve are bronze. The valve and valve seat are made of chrome-nickel steel which is hard, tough and corrosion resistant. The bucket is the only moving part. Advantages claimed for the apparatus are long chines, vibrators, etc. high efficiency, low maintenance costs, and long hose life. If the unit is used on hot air lines, an after-cooler must be used.

Assists Feeding

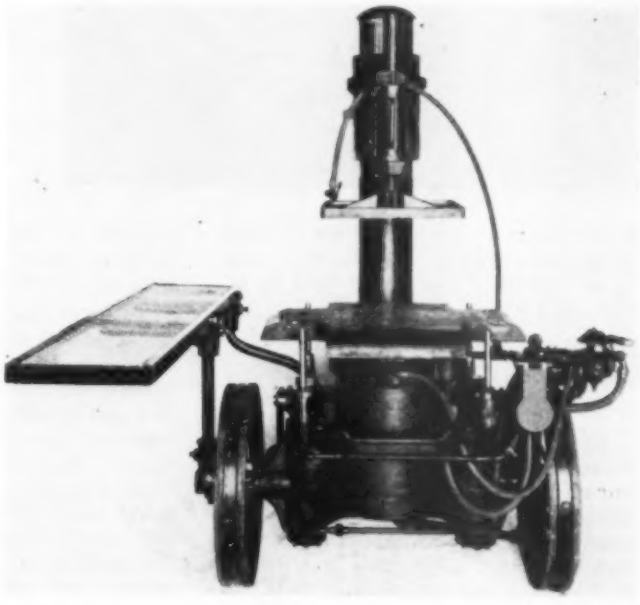
The Alpha-Lux Co. Inc., 192 Front street, New York, has placed on the market a new product known as Liquitol, developed in Germany and used in connection with the production of iron and steel castings and steel ingots. The product is applied as a layer on the hot feeder heads of iron and steel castings. Its use is said to reduce the metal necessary in risers, eliminate piping in castings, and eliminate or reduce cavities and porosities by keeping the metal in a fluid state for a longer space of time, giving it a chance to feed back into the bottom of the casting. The material is claimed not to affect the analysis or physical properties of steel ingots or castings.

Makes Speed Reducers for Electric Motors

Two new double reduction herringbone speed reducers for small electric motor drives have been introduced by the W. A. Jones Foundry & Machine Co., 4401 West Roosevelt road, Chicago. The smaller of the two machines is 18¾ inches long and 12¾ inches wide. The other machine is 21¾ inches long and 14 inches wide.

Meter Shows Operating Time of Machines

Actual total operating time of any electric equipment using alternating current may be shown by a time meter recently introduced by the General Electric Co., Schenectady, N. Y. Within the meter is a synchronous motor which operates while the circuit of the equipment is closed. This motor, through suitable gearing, drives a cyclometer five-digit counter, arranged to read in either hours or shorter intervals.



Squeezing and Stripping Operations Are Controlled by a New Type Duplex Valve Which If Thrown in One Direction Operates the Squeeze Motion and in the Other the Stripping Mechanism

Such a meter is claimed to be especially valuable in checking piecerate operation, particularly when idle-time credit is allowed in computing wages. A weekly reading of the meter shows the number of hours the machine has been in operation.

The meter is supplied on a pedestal for portable use, or with a threaded connection for permanent mounting on conduit. The meters are available for 110, 220 or 440 volts, and for 25, 50 or 60 cycles. No single device has more than one voltage or frequency rating.

Stripping Mechanism Is Widely Adjustable

Arcade Mfg. Co., Freeport, Ill., has added to its line of jolt, squeeze, stripping machines of the post type, a machine with an air stripping mechanism which has a widely adjustable range. A view of the machine is shown in the accompanying illustration. The jolting operation is controlled by a knee valve. The squeeze and strip operations are controlled by a new type duplex valve which is hand operated. If the valve is thrown in one direction it squeezes and the opposite direction it strips. The start of the strip is said to be slow and steady and can be accelerated.

The strip cylinders on the machine are cast integral with the main cylinder frame casting. The post supporting the ball bearing head is 6½ inches outside diameter with heavy walls. Dimensions of the various parts of the machine are as follows: Squeeze cylinder diameter, 10 inches; jolt, 4 inches; strip, 5 inches; strip pin centers, minimum across flask, 9¾ inches; strip pin centers, maximum across flask, 19 inches; table size, 8 x 16 to 13 x 22 inches, distance from floor to table, 27½ inches; squeeze plate, 11 x 14 inches; squeeze to table, minimum, 6 inches; squeeze to table, maximum, 16 inches; post diameter, 6½ inches; post to center of table, 11¼ inches; and net weight, 1160 pounds.

Four Wheel Steering Is Lift Truck Feature

Clark Tructractor Co., Battle Creek, Mich., is manufacturing a new line of lift trucks with four-wheel steer and rear wheel drives, on which the steering wheels can be turned to a sharp angle, enabling the operator to enter a freight car and spot his load at the far end. An accompanying illustration shows one of the new power trucks in action.

A locomotive-type cast steel frame, full floating rear axle, powerful hydraulic lifting mechanism with automatic control, positive brakes and a tractor-type gas engine with engine speed governed to less than 1400 revolutions per minute, furnishing rapid acceleration under load, are features which are claimed to insure long life and uninterrupted service.

One model has a narrow platform to accommodate standard 12-inch under clearance skid platforms. It lifts a 3-ton load in 8 seconds and its turning radius of 94 inches permits turning the corner of two intersecting 64-inch aisles with ample clearance. A heavier model lifts 4 tons in 8 seconds, has a speed of from 1 to 6 miles per hour and turns on a 94-inch radius. In both models maximum engine power is delivered to the two rear driving wheels through direct transmission. Special wide tires under the platform are claimed to reduce tire wear.

Four Wheel Steering, Rear Wheel Drive, Cast Steel Frame, Full Floating Rear Axle, Hydraulic Lifting Mechanism, Positive Brakes, and Tractor-Type Gasoline Engine Are Features of This Lift Truck

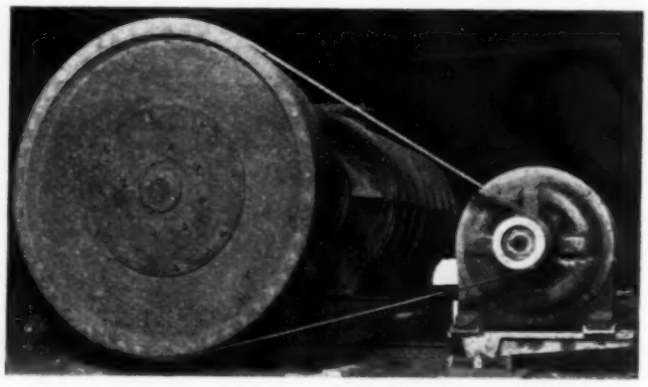
Aluminum Alloy Hoist Is Light Weight

Chisholm-Moore Hoist Corp., Tonawanda, N. Y., recently has introduced a hoist made of an aluminum alloy. Features claimed for the hoist are light weight, high strength and efficiency. The unit is portable and is equipped one-shot lubrication. Aluminum castings used in the construction of the hoist are x-ray inspected and the design utilizes a small number of parts. Other features of the hoist include easy accessibility, planetary type gears, dustproof housing, adjustable positive action brake and corrosion resistance. The unit is equipped with hardened and ground ball bearings, and is so constructed that it will lift the load from any angle.

Belt Tension in Drive Is Constant

A driving mechanism, consisting of a cast iron base, two paper pulleys and an endless belt of special construction, has been placed on the market by the Rockwood Mfg. Co., Indianapolis. The special base, used in place of the customary motor rails, consists of the base proper and two pivoted arms or brackets on which the motor is mounted.

The driving mechanism is of the short center type and the center distances are not fixed. Since belt lengths change with speed due to centrifugal tension, the drive has been designed to change the center distances with changing belt lengths. Two adjustable screws on which the pivot shaft is anchored are located in the base. Alignment of a motor may be made with a few turns of the screws and permanent elongation of the belt also is compensated in the same way. The drive is available in six sizes of bases to fit 60 cycle motors up to 50 horsepower operating at 1800 revolutions per minute. It may be used on motors up to 500 horsepower. The drive cannot operate where the axis of the driven pulley is lower than the motor axis.



Drives May Be Mounted In Practically Any Position as Long as the Axis of the Driven Pulley Is Above That of the Driver

Roller Bearings Built To Withstand Shock

Aetna Ball Bearing Mfg. Co., Chicago, recently has placed on the market a complete line of roller bearings, which are designed to sustain heavy loads and sudden shocks. One of these bearings is shown in the illustration at the bottom of this page.

The outer race is free from lips or shoulders, while the inner race has a double lip. Since the rollers are free to move longitudinally across the face of the outer race, endwise movement of the shaft due to load, expansion, contraction or distortion, is possible without danger of misalignment or cramping.

High grade bearing steel is used for races and rollers, the races being hardened, ground and lapped, while the carefully hardened rollers are finished by centerless grinding and also are ground on both ends. Retainers are designed to allow minimum width of race with maximum bearing surface, thereby allowing compact construction. Retainers may be either steel or brass. The line comprises 64 bearings, for light, medium or heavy duty, in sizes ranging from $1\frac{3}{16}$ to $10\frac{7}{16}$-inch outside diameter, being interchangeable with S.A.E. standard ball bearings.

High Grade Bearing Steel Is Used for Races and Rollers

Trade Trends in Tabloid

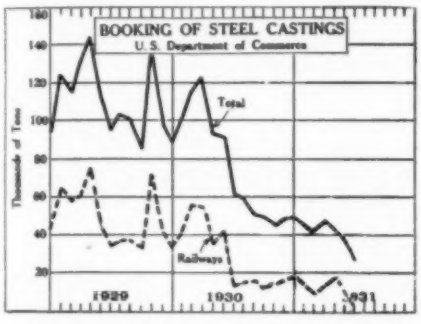
OUTWARD signs of an improvement in foundry operations are beginning to appear here and there. Of chief importance is the pickup in the shipment of pig iron to certain sections, the greatest tonnage probably being destined for automobile shops.

—T—T—

The automobile industry maintained production at about 50,000 passenger cars and trucks weekly during August, about 6000 to 7000 units less per week than during July.

—T—T—

Charting the curve of railway car loadings for 1930 and 1931 shows a marked similarity in the up and



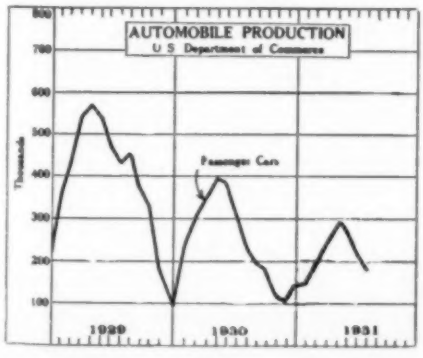
down fluctuations, with this year's curve stretching out considerable below the path charted a year ago. Loadings for the week ended Aug. 8 totaled 734,780 cars, a drop of 22,513 cars from the previous week and 169,337 from a year ago.

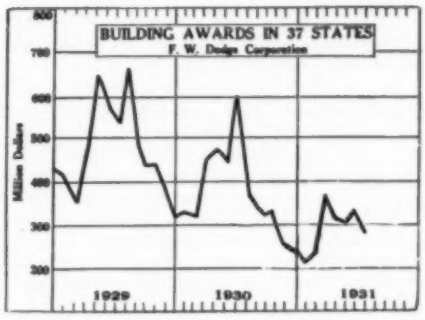
—T—T—

Prospects appeared better the latter part of August among foundries in the Chicago district for better operating schedules in September. Several stove foundries in western Michigan have increased operations and it has been indicated that at least one implement works would resume operations at a moderately heavy rate. Chicago district foundry operations at the middle of August were on the basis of 25 to 30 per cent.

—T—T—

In contrast to the usual downward trend, building awards in July





showed gains in several sections, including New England, upstate New York, Mid-Atlantic Seaboard, Pittsburgh and Chicago, according to the F. W. Dodge Corp. Total awards for the 37 states east of the Rockies were valued at $285,997,300 in July compared with a total of $331,879,700 in June.

—T—T—

Cast iron pipe manufacturers in the Birmingham district are operating at approximately 50 per cent of capacity.

—T—T—

Index of orders for foundry equipment was 38.7 in July compared with 40.9 in June, according to the Foundry Equipment Manufacturers' association.

—T—T—

Several foundries in the St. Louis district have resumed operations. Tractor and farm implement manufacturers report an unpromising outlook for the remainder of the year and schedules of jobbing shops making miscellaneous types of castings are spotty.

—T—T—

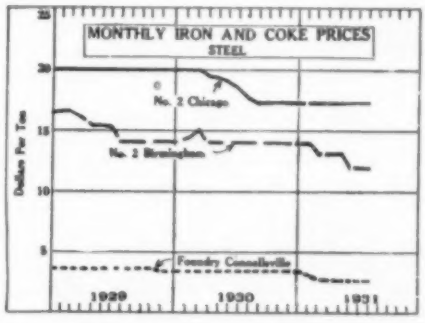
Foundries in the New York metropolitan area were operating at an average of from 20 to 25 per cent during the first part of August.

—T—T—

Orders for machine tools have declined since the high point for the year set in March, according to the Machine Tool Builders' association. Index of orders for July was 52.1 compared with 74.3 in June.

—T—T—

Deliveries of brass and bronze ingots and billets by members of the Nonferrous Ingot Metal institute



totaled 3529 tons compared with 3584 tons in June. Unfilled orders on Aug. 1 was 21,510 tons.

—T—T—

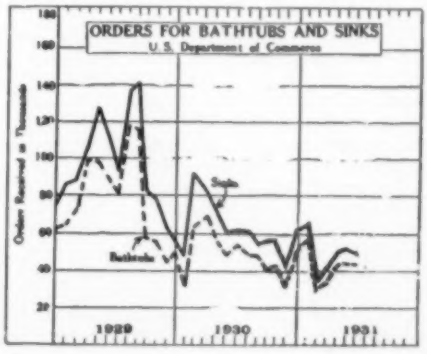
During the first three weeks in August, steel mill operations curved upward from 30 to 33⅓ per cent.

—T—T—

While only 367 freight cars were ordered in July, it is reported that several roads are considering purchases. It is interesting to note that in three of the past four years, a decided drop in car orders materialized in July.

—T—T—

Bookings of commercial steel castings in June totaled 26,041 tons compared with 39,052 tons in May, according to the department of commerce. Production for June reached 34,923 tons.



RAW MATERIAL PRICES
Aug. 20, 1931

Iron	
No. 2 foundry, Valley	$17.00
No. 2 Southern, Birmingham	12.00 to 13.00
No. 2 foundry, Chicago	17.50
No. 2 foundry, Buffalo	17.00
Basic, Valley	17.00
Basic, Buffalo	16.50 to 17.00
Malleable, Chicago	17.50
Malleable, Buffalo	17.50
Coke	
Connellsville beehive coke	$3.25 to 4.50
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.00
Scrap	
Heavy melting steel, Valley	$10.50 to 11.00
Heavy melting steel, Pitts.	10.50 to 11.00
Heavy melting steel, Chicago	8.00 to 8.50
Stove plate, Buffalo	7.75 to 8.00
Stove plate, Chicago	7.00 to 7.50
No. 1 cast, New York	7.50 to 8.00
No. 1 cast, Chicago	8.75 to 9.25
No. 1 cast, Philadelphia	11.50 to 12.50
No. 1 cast, Pittsburgh	10.00 to 10.50
No. 1 cast, Birmingham	9.00 to 10.00
Car wheels, iron, Pittsburgh	11.00 to 11.50
Car wheels, iron, Chicago	10.00 to 10.50
Railroad malleable, Chicago	8.50 to 9.00
Agricultural mal., Chicago	8.25 to 8.75
Malleable, Buffalo	10.00 to 10.50
Nonferrous Metals	**Cents per pound**
Casting copper, refinery	7.25
Straits tin	25.75 to 25.87½
Aluminum, No. 12, producers	22.00
Aluminum, No. 12 remelt	9.00 to 10.50
Lead, New York	4.40
Antimony, New York	6.60
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.80

What the Foundries Are Doing

Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

Foundry formerly occupied by J. A. Merrick, 1149 Grand avenue, Galesburg, Ill., has discontinued business.

Wolfe & Beerrstein, 610 William street, Baltimore, started their new brass foundry in July.

Alpha Brass Corp., 408 West Redwood street, Baltimore, has purchased the Liberty Brass Works, 410 West Redwood street, Baltimore.

Allied Steel Castings Co., West Harvey, Ill., will start construction at once of a new crane runway, and a storage and cleaning room.

Plant of the Barberton Foundry Co., 743 Huston street, Barberton, O., recently was damaged by fire. Loss, chiefly to patterns, is estimated at $9000.

Fire recently caused slight damage to the foundry of Chas. B. Conn Ltd., East Beardsley avenue, Elkhart, Ind., manufacturer of band instruments.

The Semi-Steel Casting Co., St. Louis, has increased its capital from $50,000 to $80,000 and contemplates expansion of plant and equipment. Harry P. Hubbell is president.

Hagerstown Bronze Aluminum Co., 710 Pennsylvania avenue, Hagerstown, Md., has resumed operations after being shut down for four months. C. R. Baumgardner is president.

Belding Foundry Co., Belding, Mich., has the largest number of men on its payroll in the history of the company. Arthur B. Johnson is manager and general superintendent.

Hudson Mfg. Co., Minneapolis, manufacturer of sanitary dairy barn and stable fixtures, will erect an addition to its plant, at 80 Harrison street, Oshkosh, Wis.

American Pattern & Mfg. Co., Racine, Wis., has been incorporated by E. J. and E. E. Beck and H. A. and T. B. Nelson, to manufacture patterns, tools, dies and fixtures.

Maytag Co. Ltd., Toronto, Ont., has been organized as an affiliate of Maytag Co., Newton, Iowa, and will establish a branch plant for the manufacture of washing machines and other devices.

Erb-Joyce Foundry Co., Vassar, Mich., recently placed its new electric furnace in operation. New molding machines also have been added to the equipment in the piston ring department. Norman Wigley is foundry manager.

Detroit-Michigan Stove Co. and Silent Automatic Corp., both of Detroit, have completed a joint merchandising arrangement covering a complete warm air heating unit, consisting of a specially designed warm air furnace and an automatic burner.

Falk Corp., Milwaukee, has received an order from the New York Shipbuilding Co., Camden, N. J., for the complete main reduction gear equipment for the U. S. S. TUSCALOOSA, light cruiser No. 37. Specifications for the gear equipment include four speed reduction units weighing 73,000 pounds each.

Iowa Machine Works & Foundry, Clinton, Iowa, is building a new foundry, 80 x 160 feet, at a cost of $30,000. The first unit, 80 x 100 feet, has been completed. A new cupola has been installed and a 10-ton capacity crane will be installed in the future. The company recently secured a $20,000 war department contract at Vicksburg, Miss.

Frank H. Reynolds Co. Inc., 1201 Sixth avenue, Terre Haute, Ind., has been organized to continue the business of Frank H. Reynolds in the manufacture of gray iron castings and machine parts and a special heat resistant casting. Company has leased a plant at the above address, formerly occupied by the Winslow Government Standard Scale Works, and has started operations. W. S. Strong is secretary.

Much of the increase in production and sales of the Aluminum Industries Inc. is due to the sharp step-up in production of Plymouth cars by the Chrysler Motor Corp. The Cincinnati company furnishes aluminum alloy pistons and valves for Plymouth cars. Both the parent plant in Cincinnati and the subsidiary at St. Cloud, Minn., have been working steadily. In the latter factory, the valve department has been operating to full capacity throughout the summer.

Dodge Steel Co., State road and Hellerman street, Philadelphia, has let contract for construction of a foundry unit.

Roc-Air Jack Corp., Spokane, Wash., has been incorporated with $25,000 capital by J. E. Bakken, Mohawk building, to operate a business as toolmaker and founder.

Harry C. Weiskittle & Co., Baltimore, recently completed the construction of two plant units, one for the manufacture of gas ranges and the other for soil pipe. The latter unit is equipped with a 72-inch cupola. Officers of the company include Harry C. Weiskittle Sr., president; Anton K. Weiskittle, vice president; Harry C. Weiskittle Jr., secretary and treasurer. Henry Meyer is foundry superintendent. The new plant is located on Philadelphia road at the Baltimore & Ohio railroad. Operations were started July 27. (Noted Feb. 15.)

New Trade Publications

INSULATING CEMENT—C. W. Poe Co., 7600 Carnegie avenue, Cleveland, in a current bulletin describes results from use of its insulating cement in minimizing heat loss.

BRONZE—General properties and applications of Tobin bronze are outlined in a publication recently issued by the American Brass Co., Waterbury, Conn. Structure of the metal and typical applications are illustrated, and physical properties and available forms are listed. The advantages of the metal are discussed.

WATTHOUR METER—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., in a recent folder describes a recording demand watthour meter. The instrument measures both kilowatt hours and integrated, block-interval demand. Construction, operation, and distinctive features are outlined.

FURNACE REVERSAL—Copies of a new bulletin, explaining automatic reversal of open-hearth furnaces and the improvements it can effect in open-hearth performance are available through the Leeds & Northrup Co., Philadelphia. The bulletin tells how reversals are made automatically, what the system is, and how it operates.

REFRACTORIES—A recent booklet from Chas. Taylor Sons Co., Cincinnati, describes high-temperature refractories produced by the company. Manufacture of the product is described, its chemical composition given, and its effectiveness under sever condition of use pointed out. Forms available are listed.

INSULATING FIREBRICK — Babcock & Wilcox Co., 85 Liberty street, New York, in a current bulletin describes a type of firebrick it has developed, which is claimed to possess high insulating qualities combined with refractory characteristics. Curves, sketches and calculations illustrate its characteristics. Advantages of the use of this material are given.

HEAT TREATMENT CHART—W. S. Rockwell Co., 50 Church street, New York, has prepared a chart on heavy paper for hanging in the shop. It contains all the factors ordinarily involved in the heat treatment of steel. Included are: Critical range diagram; general tempering colors; specific heats and melting points; conversion tables; heat equivalents.

BELT PRACTICE—Much useful information is contained in a booklet of belt practice, in connection with conveyor and elevator belts, issued recently by the Diamond Rubber Co., Inc., Akron, O. The information is based on an interchange of experience with progressive designers and touches on practical features of design and maintenance which affect the life and performance of the belt.

WELDING ALUMINUM—Welding of aluminum and its alloys is discussed in a recent booklet from the Aluminum Co. of America, Pittsburgh. Procedure in gas and electric methods found most are outlined as an aid to the practical effective for casting and rolled products welder. Examples of industrial work are illustrated. A wall chart of condensed instruction is included.

SPEED REDUCERS — Worm-gear speed reducers made by W. A. Jones Foundry & Machine Co., Chicago, are described in a recent, illustrated catalog from the company. Types and styles available are illustrated along with details of design and construction. Data on rating and selecting machines are given, and typical applications are illustrated.